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# MUKIM PULAU RUSA

## LAND USE IN A MALAYAN RIVERINE SETTLEMENT

By RUDOLPH WIKKRAMATILEKE

This paper is based on a field survey sponsored by the Department of Geography, University of Malaya. It is the writer's privilege to acknowledge the help of the following students, both in the field and in the processing of data: Hashim bin Aman, Gerald T. Pillay, Lee Ek-hua, Mohammed bin Anas, and Yang Amri bin Kammarudin.

Mukim Pulau Rusa, which covers an area of 10 sq. miles, is a minor administrative unit within the Pĕkan District of Pahang State (Fig. 1). The Mukim is situated on the left bank of the Sungei Pahang, with its downstream end about fourteen miles from the mouth of the river. The riverine boundary of the Mukim extends for about three miles along the upstream limb of the largest of several meanders in the deltaic zone of the Sungei Pahang. The landward boundaries of the Mukim are arbitrary ones. Mukim Ganchong lies to the west, Mukim Pahang Tua to the east and Mukim Pĕnor to the north.

There are three kampongs (villages) in the Mukim and, of these, Kampongs Tĕlok and Pulau Rusa along the river bank form the main centres of settlement. Access to these two kampongs is chiefly by way of the river. The other kampong is the relatively small one at Ubai in the north-east of the Mukim, which lies astride the main motor road from Kuantan to Pĕramu (Fig. 1).

### PHYSIOGRAPHY

The amplitude of relief throughout the Mukim is nowhere greater than 20 ft. Minor variations in relief are, however, frequent and in this low-lying area have considerable influence on the hydrography and patterns of land use. Three physiographic zones, namely the riverine, *pĕrmatang* (lêvée) and *paya* (swamp) zones, can be recognized within the Mukim. These zones can be associated with the mature stage of river development reached by the Sungei Pahang (Fig. 2).

(i) *The Riverine Zone.* This zone includes the islands, sand-banks and bars. There is much deposition along the left bank of the river at the present time, particularly in the area adjacent to Kampong Pulau Rusa. The configuration of the islands and the shapes and locations of the sand-banks and bars are liable to constant change with the seasonal oscillation in the water level of the river and the variations in the strength and direction of the currents. Many alterations had to be effected on the relief maps previously available before land use could be fully mapped. The bank opposite the Mukim, on the other hand, showed evidence of much corrasion.

(ii) *The Pĕrmatang Zone.* This zone is made up of a series of lêvées alternating with *alor*, that is, small medial lines of drainage (Fig. 2). This series of lêvées is indicative of successive shifts in the river channel. The highest point on the lêvées is approximately 20 ft. from the bed of the river at the river bank. The bank in the downstream sector of the Mukim, alongside Kampong Tĕlok, is steep,

the difference in level between the river bed and the top of the bank being about 16 ft. The gradient from the river bed to the bank becomes slighter upstream, the difference in levels near Kampong Pulau Rusa being about 4 ft. Landward of the lêvées the ground slopes gently to the extensive paya.

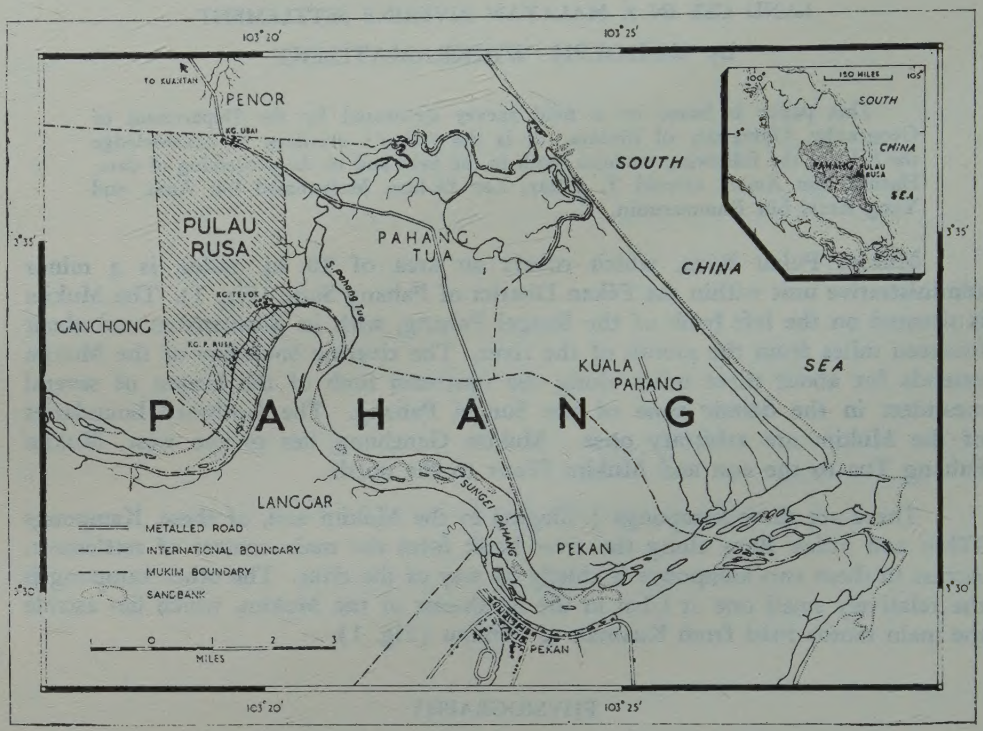


Fig. 1. Mukim Pulau Rusa: orientation map.

(iii) *The Paya.* This freshwater swamp covers the greater part of the Mukim area. The paya is waterlogged even during the driest periods of the year, with muddy ooze reaching a depth of about 3 ft. close to the lêvée margin. During the wet season the marsh becomes a lake.

The higher ground at the north-eastern extremity of the paya lies about 4 miles from the coast. This area, in which kampong Ubai is located, is one of many belts of marine deposits which characterize the east coast of Malaya.

## CLIMATE

No station records rainfall within the Mukim but statistics are available from the adjacent Mukim of Pahang Tua. There the average annual rainfall is 120·8 inches. The distribution of average monthly rainfall is shown on Fig. 3. The period of maximum rainfall is during the north-east monsoon, with the months from November to March having nearly 63% of the annual rainfall. There is little evidence of drought conditions though a relatively drier period is experienced from May to September. The rainfall is, however, highly variable and particularly so during the north-east monsoon season, as indicated by the following figures:

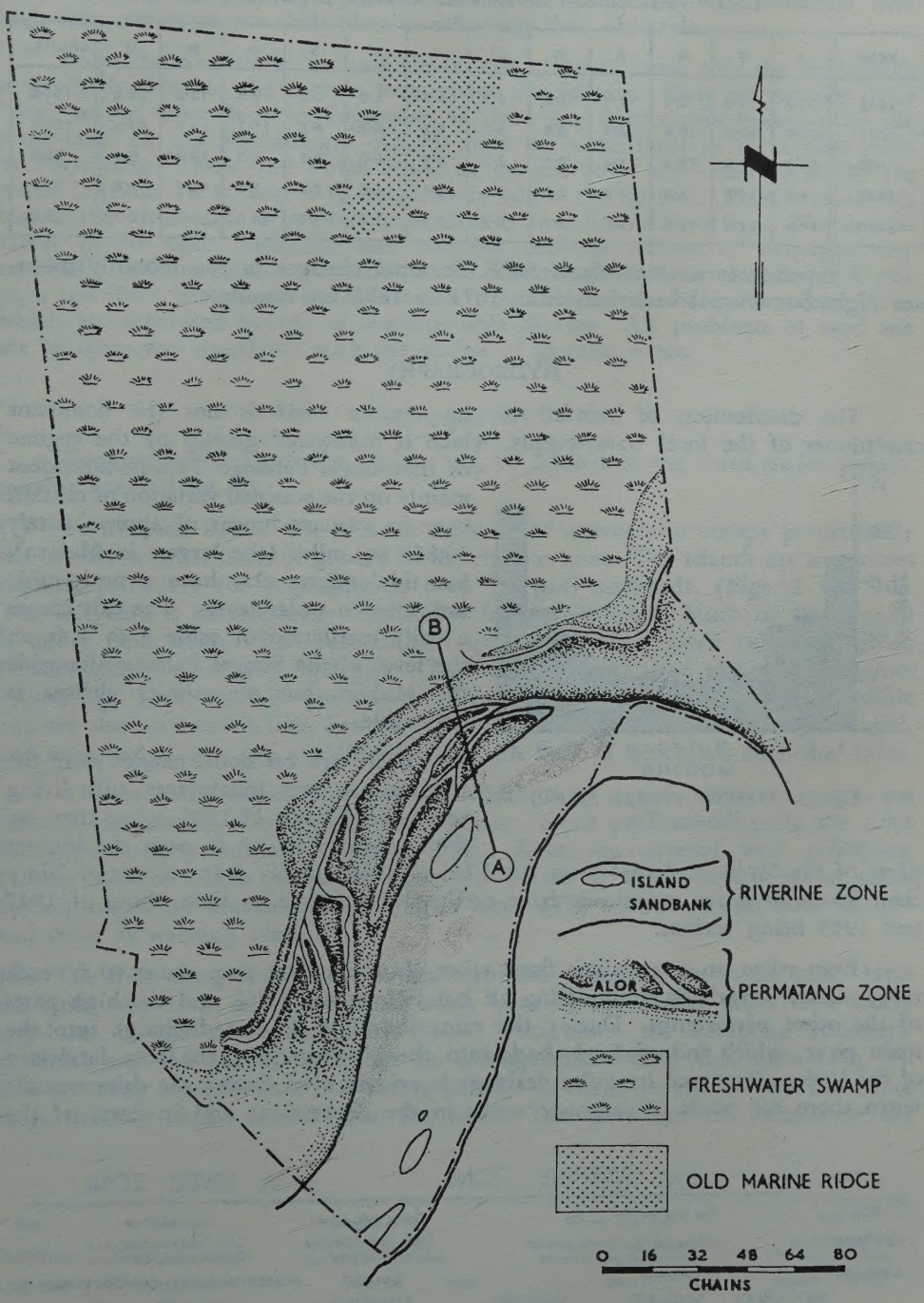


Fig. 2. Mukim Pulau Rusa: major physiographic zones.

TABLE 1: DISTRIBUTION OF RAINFALL AT PAHANG TUA, 1946-1950

| YEAR | J | F | M | A | M | J | J | A | S | O | N | D | ANNUAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1946 | 36·3 | 9·8 | 7·3 | 11·8 | 10:2 | 2:7 | 2·0 | 1·9 | 2·3 | 8·4 | 13·5 | 28:2 | 134·9 |
| 1947 | 18·8 | 20·7 | 19·9 | 4:9 | 0:6 | 5:3 | 6·9 | 6·0 | 6·6 | 10·7 | 14·2 | 43·0 | 158·0 |
| 1948 | 14·2 | 4·5 | 12·8 | 1·4 | 3:1 | 1·4 | 3·6 | 8·0 | 9:1 | 9·3 | 17·0 | 8·4 | 93·3 |
| 1949 | 8·3 | 12·5 | 4·4 | 7·3 | 8·7 | 3:5 | 5·1 | 4:6 | 3·2 | 7·4 | 18·7 | 8·5 | 92·8 |
| 1950 | 15·0 | 10·0 | 17·5 | 11·6 | 6·1 | 6·5 | 2·7 | 5·4 | 9·7 | 10·8 | 9·3 | 18·7 | 123·5 |

Temperatures average about 80°F. Seasonal changes in the monthly means are slight but diurnal variations from 10°F to 15°F are common.

## HYDROGRAPHY

The distribution of rainfall in the Mukim itself is not the dominant conditioner of the local water-supply, which is influenced greatly by the regime of the Sungei Pahang. This is dependent mainly on the seasonal variation of rainfall over its vast catchment of approximately 10,858 sq. miles (the largest in Malaya), but tidal effects also have a noticecable influence on water levels. The tide causes a daily oscillation of some 3 to 4 ft. in the level of the Sungei Pahang alongside the Mukim, but no salinity change is noticeable.

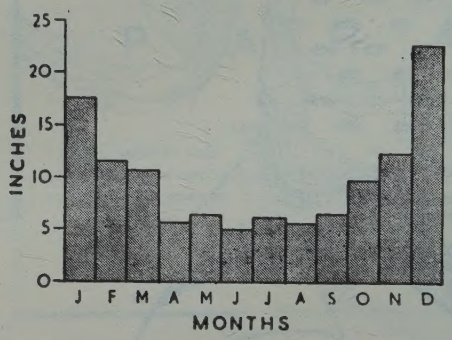


Fig. 3. Monthly average rainfall at Pahang Tua.

There are no flood gauges near the Mukim. A few inhabitants still living recall the disaster of 1926, when they say flood waters rose 20 ft. over the highest parts of the lêvées and that even the Ubai area was under 4 ft. of water. Since then floods of lesser magnitude have occurred from time to time, those of 1947 and 1953 being serious.

Even when no catastrophic flood takes place the river rises about 10 ft. each rainy season, invariably innundating all but Pĕrmatang Tĕlok and the high parts of the other pĕrmatangs. During the rains the alors do not discharge into the main river, which indeed feeds back into them, submerging the area landward of the lêvées. Poor and irregular drainage is evident even during the drier months when there are pools of stagnant water in the depressions and in parts of the

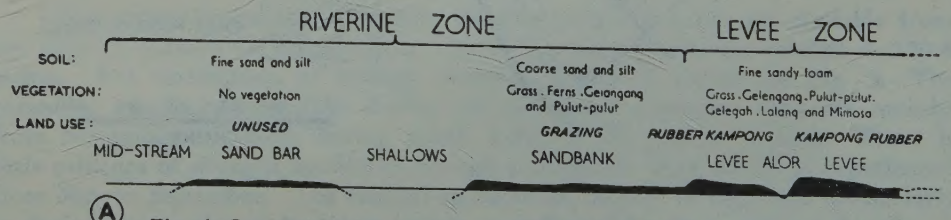


Fig. 4. Cross-section of topography (For line of section A - B see Fig. 2).

alors. During the "dry" spell, a sudden shower, particularly if it coincides with high tide, results in the little alors overflowing their channels.

From the conditions outlined above it is to be expected that the water-table is generally close to the surface throughout the Mukim. Only during the short "dry" season from June to September is there any appreciable lowering of the water-table on the pĕrmatangs. At this time the water-table in the higher parts of Pĕrmatangs Tĕlok and Pulau Rusa, as gauged from the water levels in the wells, is about 10 ft. and 6 ft. respectively below the surface. Elsewhere at this season the water-table is seldom more than 3 ft. below the surface. The critical factor is the poor, indefinite and complex drainage. Lines of drainage vary seasonally and are relative not only to the differences between water levels in the paya and river, but also to the differences in water levels in the smaller depressions which are separated by almost imperceptible divides. All problems of land use are in some way associated with the surfeit of ground water.

## TOPOGRAPHY

Topographic units in the Mukim can be related to the three major physiographic zones (Fig. 4).

(i) *The Riverine Zone.* There is no evidence of attempts to occupy permanently the islands or other units of ground in the riverine zone. The islands are sometimes casually cultivated for vegetables or used for padi seed-beds. (Figs. 2 and 10). The soil here is an extremely fertile and friable silt-loam. Much of the ground is under rank scrub. The predominant grasses are *sĕrai gajah* (elephant grass; *Pennisetum purpureum*), *gĕlĕgah* (*Themeda villosa*) and *lalang* (*Imperata cylindrica*). Local trees of use are *ara* (*Ficus spp.*), the fruits of which are edible and are also used as fish bait, *bungau* (*Lagerstroemia spp.*) used as fencing material, and *mĕmpari* (*Cassia* spp. or *Millettia* spp.), the bark of which has medicinal value.

The bars and banks, the older of which carry a rich carpet of grass, are utilized for grazing sheep, goats and buffalo. Some patches alongside the river bank, particularly around Kampong Pulau Rusa, are covered with *gĕlĕngang* (*Cassia alata* or *Cassia glauca*) of little use to man or beast. A number of small landing-stages are situated along the river bank (Fig. 5). These also carry latrines and serve as washing platforms.

(ii) *The Pĕrmatang Zone.* The lêvées form the principal settlement area. Here the soils vary from a well drained sandy-loam in the higher areas to a heavy clay-loam in the depressions and alors. Two units, the kampong (domestic gardens) and the rubber land, can be distinguished within this zone (Fig. 9). The kampong land forms a belt nearly parallel to the river and seldom extending more than 15 chains inland from the bank. The dwellings are located on the

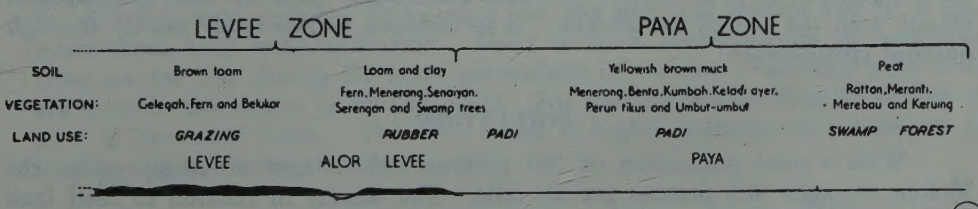


Fig. 4 (continued).

higher parts of the lêvées in a linear arrangement (Fig. 5). They stand amidst a mixture of cultivated and self-propagated trees and plants, among those of value being coconut (*Cocos nucifera*), areca-nut (*Areca catechu*), kapok (*Eriodendron arfractuosum*), bananas (*Musa* spp.), rambutan (*Nephelium lappaceum*), jack-fruit (*Artocarpus integra*), mangosteen (*Garcinia mangostana*) and *jambu* (*Eugenia* spp.). These species, however, do not provide a complete cover. There is also much *gĕlĕgah* (*Themeda villosa*), *lalang* (*Imperata cylindrica*), *mĕnkuang* (*Pandanus* spp.), *pulut-pulut* (*Urena lobata*) and other useless scrub. A few patches of rubber are scattered within this area. A broad track runs the length of the Mukim along the river bank and provides a through link with Mukim Ganchong to the west. The Sungei Pahang Tua, however, prevents through traffic to the east.

The main rubber belt lies inland of the kampong land and has a maximum width of about 30 chains (Fig. 9). The uniformity of this belt is broken by the alors and depressions which carry an assortment of ferns and aquatic plants and also by patches of crudely fenced grazing-ground, lalang and bĕlukar (scrub). In certain parts of the belt the rubber-land gives way directly to the padi-land in the paya but at others there is a short transition zone between it and the paya. Access to the paya is either over tree trunks thrown across the alors and boggy ground or over the only wooden footway, which is situated behind Kampong Tĕlok.

(iii) *The Paya.* The paya fringe has been progressively cleared for padi cultivation and pioneering for padi is still in progress. At the present time the maximum inroad made into the paya is about 25 chains. Soils in the paya vary from heavy grey-brown clays to yellowish-brown clays. They are usually structureless and waterlogged, and also inclined to be peaty in certain areas. The padi-fields, when not under crop, carry a lush growth of mĕnerong grass (*Scirpus grossus*). Rest sheds, or *pondok,* of a semi-permanent character line the perimeter fence designed to keep livestock away from the padi-fields. Inland of the padi-fields the swamp forest comes into its own, the main canopy being about 60-80 ft. high. The principal trees are *mĕranti* (*Shorea* spp.), used for making boats and the side walls of dwellings; *mĕrbau* (*Intsia bakeri*), much in demand as supporting timber, and *kĕruing* (*Dipterocarpus* spp.), also used for construction purposes. Much ratan is also available in the swamp forest.

Kampong Ubai in the north-east sector of the paya consists of a small group of dwellings located on either side of the motor road. The soils on the higher ground in the area vary from dark brown to yellowish-brown coarse sands which are slightly saline. Here there are many coconut palms and other garden crops and also patches of bĕlukar, some of which are being cleared for rubber. Portions of the surrounding swamp have previously been cultivated with padi, but the greater part of them have now been abandoned. Ubai has little geographical affinity with the rest of the Mukim. It is included in this study merely through political circumstance.

## POPULATION

With a total population of 785 persons and an area of 10 sq. miles, the Mukim averages 78·5 persons per sq. mile. The density in relation to used land is, however, 299·6 persons per occupied sq. mile. The bulk of the population is in

Kampongs Pulau Rusa and Tĕlok, the Ubai area having only 9·4% of the total population.

Of a total of 152 dwellings in Kampongs Pulau Rusa and Tĕlok, 146 were found to be occupied by 147 households. In Ubai 14 of the 17 dwellings were occupied by 15 households. The population is almost exclusively Malay, the only minority group being 19 Chinese who live in Ubai.

TABLE 2: MUKIM PULAU RUSA: POPULATION AS COUNTED IN AUGUST, 1956

| RACE | ADULT MALE | ADULT FEMALE | CHILDREN UNDER 15 YEARS | TOTAL POPULATION |
|---|---|---|---|---|
| MALAY | 190 | 229 | 347 | 766 |
| CHINESE | 6 | 4 | 9 | 19 |
| TOTAL | 196 | 233 | 356 | 785 |

The figures in Table 2 show an increase of 104 persons or 15% in nine years over 681 persons reported by the 1947 census.[1] The 1947 figure comprised 658 Malays, 8 Chinese and 15 Indians. The 15 Indians reported in 1947 lived in the Public Works Department quarters at Ubai and have now left the Mukim. No official figures for birth rates, death rates and infant mortality are available for the Mukim, but for the State of Pahang the figures in 1954 were 39·3 per thousand, 13·8 per thousand and 89·0 per thousand respectively. There has also been a considerable migration away from the Mukim. Householders reported that 71 grown-up children (47 males and 24 females) had left and were now living outside the Mukim.

*Housing*

Of the 169 dwellings in the Mukim, 162 were built on stilts and 7 were grounded, all of the latter being shop-houses. One hundred and thirty-eight of the houses were on wooden stilts, with rough, plank side-walls and atap roofing, 21 dwellings had zinc roofing and of these the majority had concrete stilts, and 10 dwellings had mixed zinc and atap roofing. Of the 169 dwellings, 162 were of multiple construction with the fireplace in a separate room and the remaining 7 were single-room dwellings incorporating fireplace and house under one roof.

*Domestic Water-Supply*

There are 48 wells in the Mukim and of these 21 are in Kampong Ubai (Fig. 5). However, only 9 wells are over 10 ft. in depth and of these only 3 are lined with either bricks or cement. Seventy-two households reported using wells for domestic water-supplies, 72 as using only the river and streams and 18 as using water from both wells and river. There is much contamination of well water from surface flow during the rains, particularly in the case of unlined wells which are more in the nature of muddy pools. For bathing and washing of clothes the river is the usual venue. The river water is highly polluted on account of the landing-stages housing latrines as well.

1. M. V. del Tufo, *A report on the 1947 census of population* (London, 1949), p. 148.

*Literacy*

The literacy rate, based on the ability to read and write colloquial Malay, was 41% of those over 15 years of age. For men over 15 years the rate was 67·3% and for women 18·9%. Elementary vernacular education is provided by the Government-sponsored Malay School at Kampong Pulau Rusa. The school had a staff of 5 and a student enrolment of 52 boys and 53 girls in August 1956.

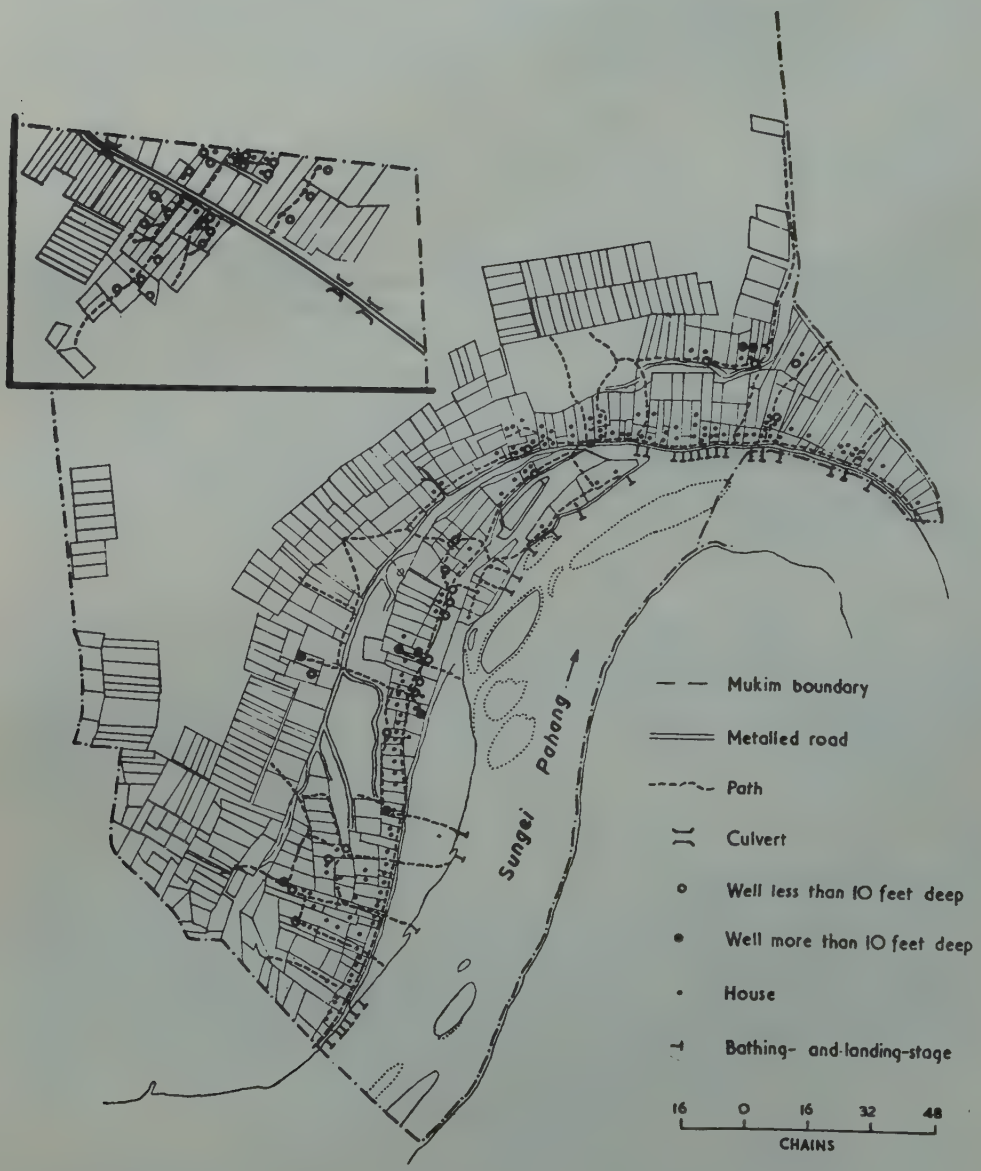


Fig. 5. Distribution of field lots, dwellings and public utilities. Inset: Ubai area.

*Movement of People*

Apart from some movement, particularly to and from the adjacent Mukims of Pahang Tua and Ganchong, for work and social purposes, journeys further afield from the Mukim are infrequent. Two persons in the Mukim own and operate boats powered with small inboard motors to handle the small volume of traffic to Pĕkan. Though each boat carries on the average only about five persons from the Mukim to and from Pĕkan each day at a charge of $1 per round trip, the carrying of goods and additional custom en route enable the boatmen to make a profit of between $3 to 5 per day. The goods carried from the Mukim to Pĕkan consist mainly of rubber, copra, coconut, bananas and poultry. The return cargo consists mainly of foodstuffs and other provisions for the 12 small shops in the Mukim.

Within the Mukim, however, there is considerable movement of pedestrians and cyclists. There are 124 bicycles belonging to 116 of the households. This internal traffic is heaviest on the broad track along the river-front. The school, the mosque, and the shops are all adjacent to this main thoroughfare. On the whole the people in the Mukim live a life of comparative isolation.

## LAND ALIENATION

*Tenure*

According to the nature of title the following six categories of land can be identified.

(i) *Land under Entry in the Mukim Register.* EMR. lands are those which have been officially surveyed into lots and to which permanent title is secured and maintained by peasants through the payment of survey and registration fees, premiums and annual land rents.[1] A holder of EMR. lands enjoys all privileges of private ownership, including that of disposal by sale.

(ii) *Land under Approved Application.* AA. lands are those whose alienation has been approved, but title to which has not been entered in the Mukim Register since the lands have not been officially surveyed and demarcated. Survey and registration fees, as also premiums and annual rents, are similar to those for EMR. lands. It must be stressed that all applications for land, whether for new lands or lands previously alienated and subsequently vacated, are first listed as Approved Applications.

(iii) *Land under Temporary Occupation Licences.* TOL. lands are allocated annually at the discretion of the District Office for the cultivation of

1. Of these charges only the registration fee of $2 and the cost of boundary stones at $2 per stone are fixed; the other charges vary according to the use for which the land is alienated and are as follows:—

(a) Padi land - - Survey fees: $1 per acre, with minimum charge of $3.
Premium: nil.
Rent: $1 per acre per year.

(b) Rubber land - - Survey fees: $37.50 for 1 to 5 acres, with $6 for every additional acre.
Premium: $15 to 18 per acre.
Rent: $1.50 per acre per year for first six years, and $6 per acre per year thereafter.

(c) Kampong land - Survey fees: as for rubber.
Premium: as for rubber.
Rent: $2.40 to $3 per acre per year.

non-perennial crops only. No survey fees or premiums are levied and the annual rent seldom exceeds $2 per acre for padi-land. For other crops such as banana and pineapple the rent is $4 per acre per year.

(iv) *Lands Reverted to State.* These are lands which have been taken back by the State as a result of forfeiture of title through failure to pay dues or through lack of a legal heir to the land.

Sungei Pahang
Lots held by Entry in the Mukim Register (E.M.R.)
Lots held by Approved Application (A.A.)
Lots held by Temporary Occupation Licence (T.O.L.)
Lots reverted to State
Public reservations
Land not alienated previously
Mukim boundary
Metalled road
16 0 16 32 48
CHAINS

Fig. 6. Land classification by title, August 1956. Inset: Ubai area.

(v) *Lands Reserved for Public Use.* These lands include State land set apart for grazing and for cemeteries and also for mosques, schools and other public buildings.

(vi) *Lands not previously alienated.* These consist of State land which has not been included in categories (i) to (v).

The present extents of the above six categories of land are set out in Table 3, and their distribution in the Mukim is shown on Fig. 6.

TABLE 3: MUKIM PULAU RUSA: LAND CLASSIFICATION BY TITLE, AUGUST 1956

| LAND | NO. OF LOTS | ACREAGE | PERCENTAGE OF TOTAL MUKIM AREA |
|---|---|---|---|
| EMR. | 356 | 994·88 | 15·54 |
| AA. | 110 | 365·89 | 5·71 |
| TOL. | 19 | 25·92 | 0·40 |
| REVERTED TO STATE | 51 | 156·23 | 2·44 |
| RESERVED FOR PUBLIC USE | — | 292·46 | 4·56 |
| NOT PREVIOUSLY ALIENATED | — | 4,564·62 | 71·35 |
| TOTAL MUKIM AREA | | 6,400·00 | 100·00 |

Note.—All alienated land, except 156·25 acres around Kampong Ubai, is within the Malay Reservation which extends in a belt from two to four miles wide along the bank of the S. Pahang.

The 4,564 acres listed in the above table as lands not previously alienated are nearly all paya land. There is little new land available for alienation on the pĕrmatangs or other high ground. The areal expansion of land occupance must, therefore, necessarily involve further reclamation or pioneering in the paya. The small number of Temporary Occupation Licences is due more to the fact that such allocations are not favoured as a matter of policy than to the lack of demand for land under this category. It is maintained that to allocate land freely under such licences is to give legal sanction to shifting cultivation, a method considered detrimental to planned land-use. Besides, it is argued that a holder of a temporary occupation licence has little incentive to maintain and improve his land.

All except 2 of the 51 lots listed as Reverted to State are former padi-lands in the paya (Fig. 6). This is indicative of the unrewarding nature of continued work on these lands. It is also significant that the greater number of the lots which have reverted to the State are in Kampong Ubai, where one would with good reason assume that other avenues of employment are more frequent or that the inhabitants are less reluctant to give up their traditional attachment to the land.

### *The Demand for Land*

The number of lots which have reverted to the State should not be considered to indicate a tendency towards mass abandonment of the land, since not only is new land being taken up but such lots, particularly those on ground away from the paya, may also be re-applied for at a later date. For example, a total of 110 lots covering 460·03 acres were alienated during the period 1950-56. These included the 110 lots covering 365·89 acres currently listed as Approved Applications, and 39 lots covering 94·15 acres which are now listed as EMR. land. Furthermore, there were 28 pending applications for 64·29 acres of land under preliminary consideration by the authorities in August 1956.

*Land Ownership*

According to official records there were 881 claims to the 485 lots (aggregating 1,386·69 acres) alienated in August 1956. The total number of claims was obtained by counting the number of names listed in the Official Registers. The actual number of landowners cannot be ascertained directly from the Registers since no addresses are given. A given name recurring in different entries may or may not refer to the same person. The average extent of each claim under each of the three categories of alienated land is given in the following table.

TABLE 4: MUKIM PULAU RUSA: CLASSIFICATION OF LOTS AND CLAIMS TO LAND

| TYPE OF TITLE | NO. OF LOTS | TOTAL ACREAGE | NO. OF CLAIMS | AVERAGE EXTENT OF EACH CLAIM (ACRES) |
|---|---|---|---|---|
| EMR. | 356 | 994·88 | 740 | 1·3 |
| AA. | 110 | 365·69 | 122 | 3·0 |
| TOL. | 19 | 25·92 | 19 | 1·3 |
| ALL ALIENATED LAND | 485 | 1,386·69 | 881 | 1·7 |

An examination of the Registers showed that changes of claims to ownership of 105 of the 365 EMR. lots were last recorded in the period 1951-55, of 106 lots during 1946-50 and of 18 during 1941-45. Among the remaining 126 EMR. lots there have been no recorded changes of claims to ownership of 65 lots since 1940 and of 61 lots after 1935. The claims to all but 5 of the 110 AA. lots have been recorded after 1950 and all 19 TOL.'s have been allocated after 1954.

The information as to land-ownership in the Official Registers was of doubtful value, not only because the number of owners could not be ascertained directly but also because:—

(i) There were instances of no revision being made following the death of the recorded owner. Names of heirs to such lands are frequently not substituted until there is a legal necessity for doing so.

(ii) There were also cases of fragmentation or consolidation of holdings (through sale or mutual agreement), without the transactions being officially recorded.

(iii) In practice more than one person had been party to the purchase of a lot but only one name was listed in the register.

Since the attempt to investigate land-ownership by questioning people at work on their field-lots would inevitably have led to incomplete coverage (since most lots had no one on them for long periods), interrogation was conducted in the houses as well. It was established that all except 15 of the 162 households living in the Mukim had title to some land. Householders without any land included 5 school-teachers, 2 boatmen and 2 employees of the Public Works Department. A total of 568 claims to land existed on this basis. These were made up of 427 claims to EMR. lands, 122 to AA. lands and 19 to TOL. lands. It will be seen that the discrepancy between the above figures and the official figures (Table 4) relates to the EMR. lands. This is to be expected since no changes of ownership for as many as 126 of the 356 EMR. lots have been made in the official registers since 1940. Unfortunately no definite evaluation of the ownership figures obtained through field investigation is possible either independently or in

comparison with official figures, since the data obtained in the field are subject to the following limitations:—

(i) It cannot be claimed that all the owners living outside the Mukim were accounted for. Sixty-eight lots covering 223 acres were found to be in the hands of persons living outside the Mukim. These 68 lots were made up of 27 EMR. lots covering 81·6 acres and 41 AA. lots covering 141·6 acres. The majority of the absentee owners, particularly those holding AA. lots,

Fig. 7. Land ownership according to official records. Inset: Ubai area.

lived in the adjacent Mukims of Ganchong and Pahang Tua, but some of the owners of EMR. lots lived as far away as Kuantan, Luit, Pĕkan and Ĕndau.[1]

(ii) It was also not possible to establish fully ownership claims by persons resident in the Mukim in cases where the names of heirs to land had not been officially substituted. Conflicting claims were made either because of genuine errors in quoting lot numbers or because of the complex changes in family relationships. The divorce rate is high and divorcees seldom remain unmarried for long. In the period 1947-1956 there were 58 divorces and 155 marriages in the Mukim. Claims to land are extremely involved if the parties to a divorce each have issue by a later marriage, particularly if the land has been jointly owned by them in the first instance.

It must be stressed at this juncture that a full investigation of land-ownership should include data as to the extent of land owned by an individual or household. Unfortunately many joint owners are unable to state the extent of their holdings. This problem can be effectively resolved only by taking each and every claimant to identify his or her holding, both in the Mukim and if necessary outside it. For example, 28 households reported owning and working lands in the adjacent Mukims of Ganchong, Pahang Tua and Pĕnor. Even if this task of identifying the scattered, non-contiguous and fragmented holdings were possible, some holdings are not areally divided but worked as one joint unit. It is for these reasons therefore, that no attempt has been made in this study to calculate extents of holdings and to tabulate the distribution of holdings by size. It is for the same reasons, too, that no analysis of crop distributions by size of units has been included in the later sections of this work.

*Sizes of Lots and Fragmentation*

The average size of lots in each of the three categories of alienated land is given below.

| TYPE OF TITLE | NO. OF LOTS | TOTAL ACREAGE | AVERAGE SIZE OF LOT (IN ACRES) |
|---|---|---|---|
| EMR. | 356 | 994·88 | 2·8 |
| AA. | 110 | 365·89 | 3·3 |
| TOL. | 19 | 25·92 | 1·3 |
| ALL ALIENATED LAND | 485 | 1,386·69 | 2·8 |

Lots over 5 acres in extent are limited in number. There were only 24 EMR. and 10 AA. lots in this category. The majority of the lots are of about 2 acres each. Fragmentation of lots, particularly of EMR. lots, is high (Figs. 6 and 7). Even in the case of the 24 EMR. lots of over 5 acres each (totalling 162·2 acres), there were 74 claimants, with each claim amounting to only 2·2 acres. On the other hand the extent of each claim for the 10 newer AA. lots was 7·7 acres. According to the official registers (Table 4), 245 of the 740 claims to EMR. lots relate to 47 lots, each with 4 or more claimants, the average extent of each claim in this instance being only 0·6 acres (Figs. 6 and 7). The last recorded changes of ownership of all but 3 of these 47 lots have been made after 1945. This fact tends to throw further doubt on the validity of the figures for claims to the

1. The coastal towns Kuantan and Endau are respectively 26 miles north and 60 miles south of Pekan (Fig. 1), and Luit 40 miles upstream from Pulau Rusa.

remaining 309 EMR. lots where no changes have been officially recorded since 1945. Fragmentation of lots must, in fact, be far greater than that indicated in Figure 7.

## LAND USE

A total of 1,679·15 acres or 26·23% of the Mukim area was under occupance. Of this 1,526·52 acres, amounting to 23·85% of the Mukim area, were in Kampongs Tĕlok and Pulau Rusa and only 152·63 acres or 2·38% of the Mukim area in Kampong Ubai. The classification of land use according to official records is set out in Table 5.

TABLE 5: MUKIM PULAU RUSA: LAND USE ACCORDING TO OFFICIAL RECORDS

| TYPE OF USE | EMR. LOTS | | AA. LOTS | | TOL. LOTS | | TOTAL ACREAGE | PERCENTAGE OF TOTAL ALIENATED LAND |
|---|---|---|---|---|---|---|---|---|
| | No. OF LOTS | ACREAGE | No. OF LOTS | ACREAGE | No. OF LOTS | ACREAGE | | |
| 1. WET PADI | 118 | 372·27 | 39 | 117·28 | 3 | 6·00 | 495·55 | 29·52 |
| 2. DRY PADI | 36 | 89·61 | — | — | — | — | 89·61 | 5·34 |
| 3. RUBBER | 18 | 53·93 | 45 | 153·13 | 6 | 6·19 | 213·25 | 12·70 |
| 4. KAMPONG | 138 | 335·72 | 5 | 19·23 | — | — | 354·95 | 21·13 |
| 5. COCONUTS | 8 | 23·05 | 12 | 49·75 | — | — | 72·80 | 4·33 |
| 6. FRUIT | 19 | 56·31 | 9 | 26·50 | — | — | 82·81 | 4·93 |
| 7. VEGETABLES & FOODSTUFFS | — | — | — | — | 10 | 13·73 | 13·73 | 0·82 |
| 8. GRAZING LAND | — | — | — | — | — | — | 279·09 | 16·62 |
| 9. CIVIL GROUNDS | — | — | — | — | — | — | 13·37 | 0·80 |
| 10. UNCLASSIFIED | 19 | 63·99 | — | — | — | — | 63·99 | 3·81 |
| TOTAL | 356 | 994·88 | 110 | 365·89 | 19 | 25·92 | 1679·15 | 100·00 |

Note: 1. The 6 TOL.'s for rubber refer to licences to tap trees which are extensions from EMR. lots into State Land. No TOL.'s are granted for planting rubber.

2. Civil grounds include the following cemeteries, 8·09 acres; school, 2·88 acres; mosque, 1·0 acre; and *penghulu's* (headman's) residence, 1·4 acres.

3. Unclassified grounds are lots for which no particulars are given in the official records. Many of them are in the paya and are obviously for wet padi.

4. The number of lots is specified only in the case of private ownership.

The 36 dry-padi lots listed in Table 5 are in the pĕrmatang zone (Fig. 8). This preference for dry padi (*tĕnggala*) is indicative of the difficulties associated with the cultivation of wet padi in the paya. The comparatively small number of lots under rubber is also of interest. It should, furthermore, be noted that kampong lots (domestic gardens) carry an assortment of cultivated plants including coconuts and fruits. The acreage under vegetables and other foodstuffs is remarkably small and this is characteristic of most Malay kampongs. It is also significant that the whole of this acreage is on temporary holdings.

The land-use distribution determined by field investigation in August 1956, (Table 6 and Fig. 9), was found to be different from that in the official records (Table 5 and Fig. 8).

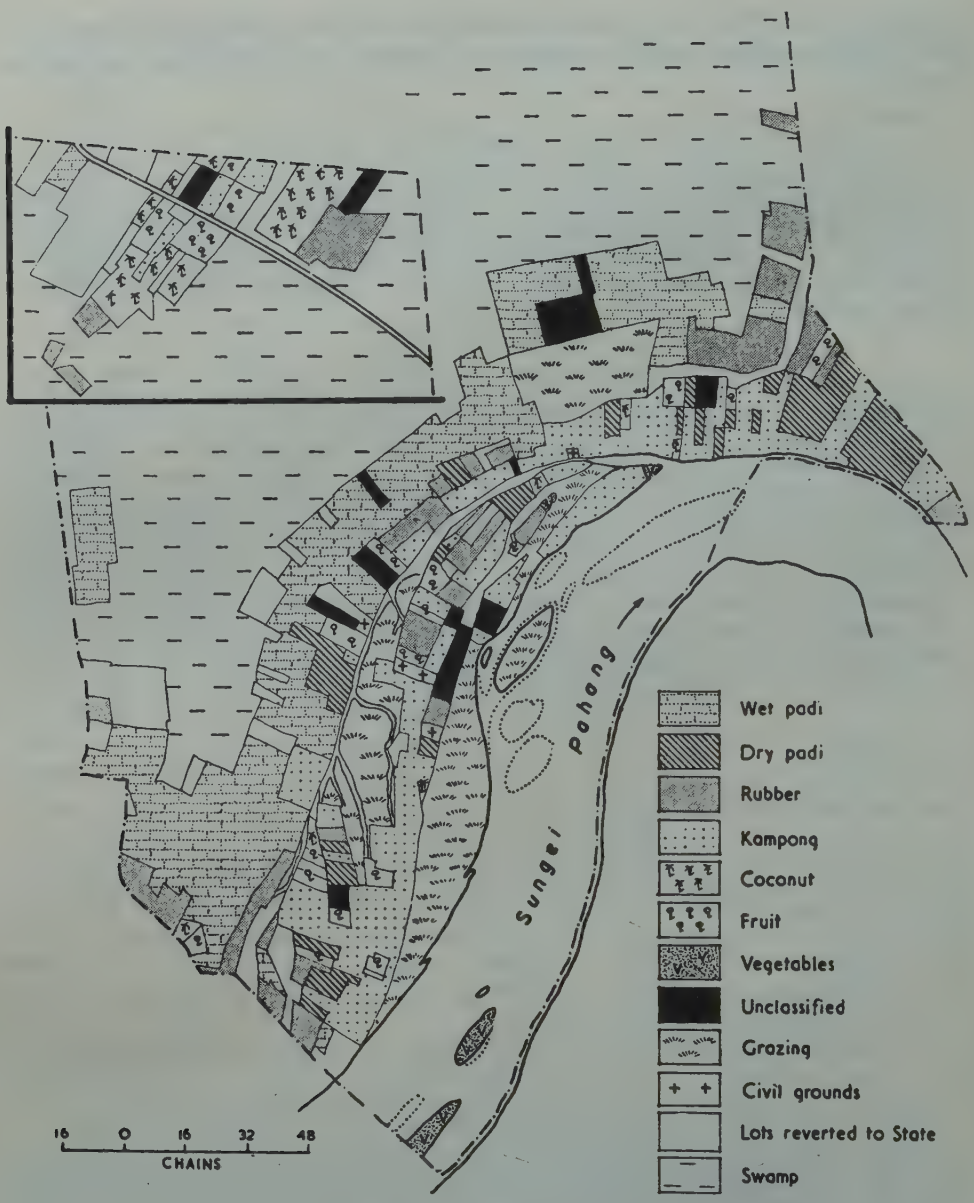


Fig. 8. Land use according to official records. Inset: Ubai area.

The principal point of interest shown by Table 6 is the discrepancy regarding land under rubber, the observed acreage being nearly three times that in the official records. This extension of rubber cultivation has been mainly on lands previously declared to be dry padi (*tĕnggala*), fruit and kampong (Figs. 8 and 9). The official figures show 89·61 acres of tĕnggala, 82·81 acres of fruit and 354·95 acres of kampong (Table 5). In August 1956 the respective figures were estimated at nil, 7·14 acres and 154·11 acres. If one were to assume that the earlier cultivation of tĕnggala was in response to conditions suitable for padi, then it would appear

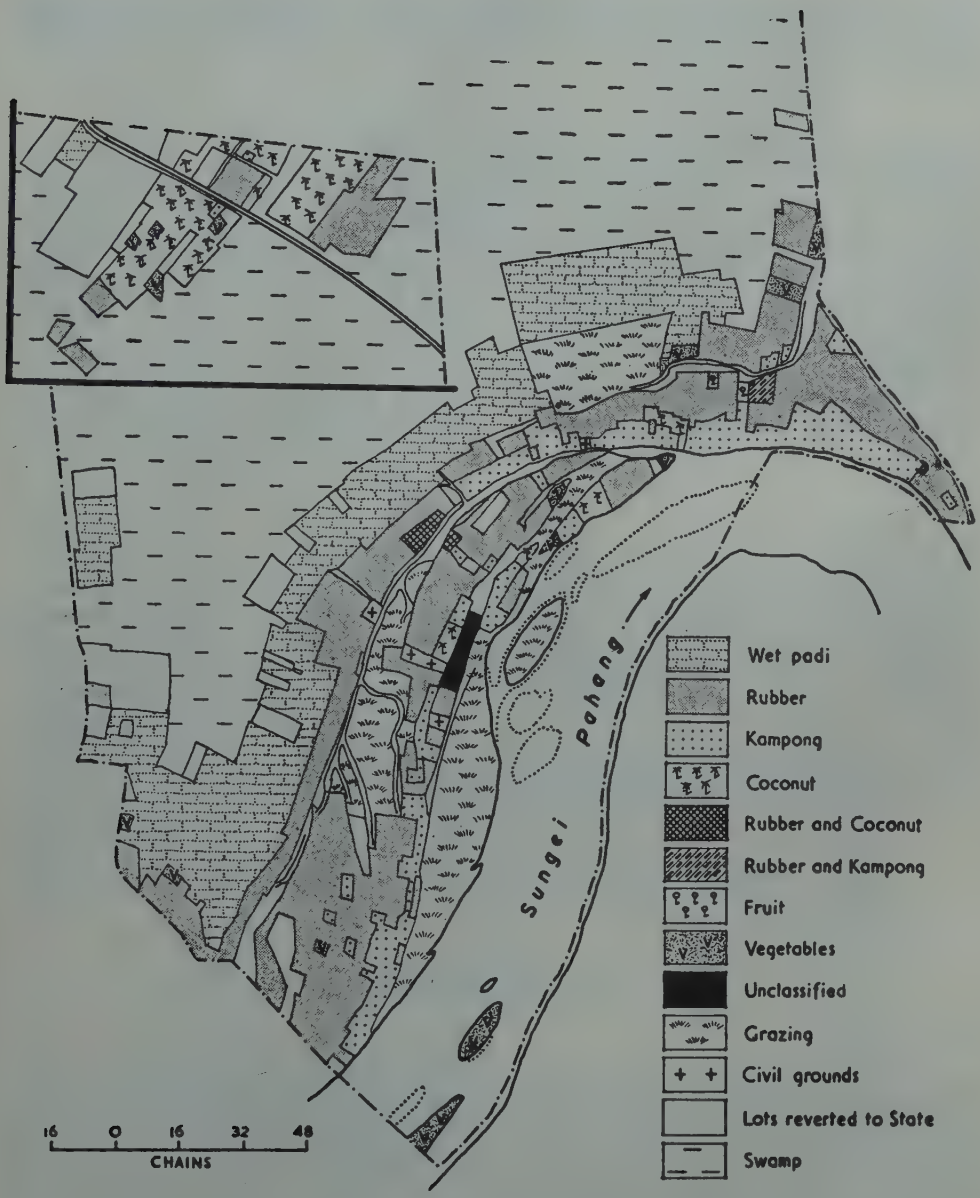


Fig. 9. Land use as mapped, August 1956. Inset: Ubai area.

that much rubber is now on ground that is basically unsuited to it. It is doubtful whether the State is now receiving the increased revenue due to it by the substitution of rubber for the crops originally stipulated in the titles. Rubber was found to be cultivated even on 4 AA. lots currently listed as being under fruit and on 2 AA. lots listed as under padi. On the other hand there is no marked difference between the acreages for wet padi in Tables 5 and 6. This indicates that the traditional subsistence economy has not been completely displaced despite the

obvious attractiveness of other crops such as rubber. The padi-land would be of value, if the rubber market were to crumble, and if rubber prices remained high one could always raise some padi to supplement cash earnings, or as an alternative even rent out the padi-land.

TABLE 6: MUKIM PULAU RUSA: LAND USE AS OBSERVED IN AUGUST 1956.

| Land Use | Acreage on EMR. land | Acreage on AA. land | Acreage on TOL. land | Total Acreage | Percentage of total alienated area | Percentage of total alienated area according to official records |
|---|---|---|---|---|---|---|
| 1. Wet padi | 349·86 | 114·77 | 6·00 | 470·63 | 28·03 | 29·52 |
| 2. Dry padi | — | — | — | — | 0·00 | 5·34 |
| 3. Rubber | 424·28 | 173·32 | 6·19 | 603·79 | 35·96 | 12·70 |
| 4. Kampong | 148·60 | 5·51 | — | 154·11 | 9·18 | 21·13 |
| 5. Coconuts | 51·44 | 62·06 | — | 113·50 | 6·76 | 4·33 |
| 6. Fruit | 5·56 | 1·58 | — | 7·14 | 0·43 | 4·93 |
| 7. Vegetables & foodstuffs | 6·76 | 8·65 | 13·73 | 29·14 | 1·72 | 0·82 |
| 8. Grazing lands | — | — | — | 279·09 | 16·62 | 16·62 |
| 9. Civil grounds | — | — | — | 13·37 | 0·80 | 0·80 |
| 10. Unclassified | 8·38 | — | — | 8·38 | 0·50 | 3·81 |
| TOTAL | 994·88 | 365·89 | 25·92 | 1,679·15 | 100·00 | 100·00 |

Note: 1. The number of lots under each category of land use cannot be ascertained, as more than one type of use was frequently identified within a given lot. Eighty-two of the 485 lots in the Mukim were so used. Of the remaining 403 lots, 157 were exclusively under padi, 148 under rubber, 54 under kampong, 28 under coconut, 14 under vegetables and 2 under fruit.

2. The area under each type of use was determined by estimating the proportion of a lot under a specified type of use. A certain degree of error is inevitable under these circumstances. It is, however, maintained that the figures in Table 6 give a truer picture of the land-use distribution than those in Table 5. Column 7 has been set out in order to indicate the discrepancy between these two sets of figures.

## PADI CULTIVATION

### *Ownership*

Of the 162 households in the Mukim, 114 between them owned 393·0 acres of padi-land within the Mukim. The remaining 77·5 acres of the total padi acreage of 470·6 were owned by persons residing outside the Mukim.[1] Only 13 of the households in the Mukim reported that they did not work any padi-land. Of the 149 households working padi-land, 121 did so within the Mukim, 26 outside the Mukim and 2 worked lands both within and outside the Mukim. Of the 28 working lands outside the Mukim, 26 worked lands in Pahang Tua, 2 in Ganchong and 1 in Pĕnor.

Of the 123 households living in and working within the Mukim, 94 themselves worked lands to which they had title, 4 rented lands totalling 4 acres in extent by paying the land rents due from the owners, 15 rented a total of about 25 acres

1. The acreages stated in this section are subject to the considerations regarding land-ownership indicated previously.

by payment in kind, and 8 borrowed free of charge 10·2 acres. No details are available for 2 households absent during the survey.

*Productive and Unproductive Extents*

There is considerable variation in the cultivated area from year to year. It was estimated in August 1956 that only about 324 of the 470·6 acres of padi-land would be brought under cultivation during the 1956-57 season. Of the remaining 146 acres, 94 appeared to be abandoned for the current year at least and 52 acres were new land not yet fully prepared for cultivation (Fig. 10). The greater part of the 94 currently unused acres are in Paya Kuban Bugis, Paya Padang Lalang and Paya Tĕrang. In these areas padi cultivation is reportedly more difficult and yields more unreliable than in others on account of the peaty soil and extreme water-logging. The greater part of the 52 acres of Pioneering land is in the eastern part of Paya Sĕbĕrang Alur, reputedly the best padi-land from the point of view of soil and drainage conditions, and Pĕrmatang Ubi (Fig. 10). In the latter area much of the land is owned and cultivated by people from the neighbouring mukim of Ganchong.

*Cycle of Cultivation*

Padi-growing in the Mukim is precarious. Man has little control over the seasonal water-supply which is dependent entirely on the vagaries of the rainfall and the intensity of the annual floods. There are no irrigation canals and, more important still, no drainage channels to control the water level in the fields once the crop has been planted. Three minor drainage ditches, about 2 ft. deep and 1½ ft. wide, were dug at various times between 1947 and 1954 but all have by now been obliterated.

The official planting schedule given below (Table 7) has been drawn up in an effort to minimize the fortuitous nature of padi-growing by adjusting the cycle of cultivation to the seasonal variation in the natural water-supply.

TABLE 7: MUKIM PULAU RUSA: OFFICIAL PADI-PLANTING SCHEME, 1956 SEASON (GOVERNMENT DEPARTMENT OF AGRICULTURE)

| | | |
|---|---|---|
| 1. | Complete repairs to bunds, etc. | 25/2/56 |
| 2. | Commence sowing of seed-beds | 1/3/56 |
| 3. | Complete sowing of seed-beds | 31/3/56 |
| 4. | Commence fencing of paya | 1/4/56 |
| 5. | Complete fencing of paya | 30/4/56 |
| 6. | Begin preparation of paya | 24/4/56 |
| 7. | Complete preparation of paya | 1/6/56 |
| 8. | Begin transplanting | 15/5/56 |
| 9. | Complete transplanting | 1/6/56. |

The principal aim of the above schedule is to enable the harvesting of a long-term 7½-month padi-crop before the onslaught of the north-east monsoon about December and the ravages of the consequent floods which result in damage to the mature crop either through direct submersion or through sheet run-off from the fields. The schedule is, however, not followed by the farmers for the following reasons. First, the inherent weakness of the schedule is that it fails to recognize local conditions. It makes inadequate allowance for differences in water levels between one part of the paya and another and between one lot and another at any one time of the year. For example, it is not possible to gain access to

some of the lots during February, let alone to repair the bunds, as these lots are under more than 3 ft. of water at that time. On some fields clearing of the undergrowth and preparation of the surface has to be postponed until the end of the drier period in August when the water level has decreased sufficiently to permit of these operations. Again, transplanting on some lots is delayed until such time as the water level has dropped sufficiently or until the seedlings in the nurseries have reached a suitable height to overcome the excess water. This often

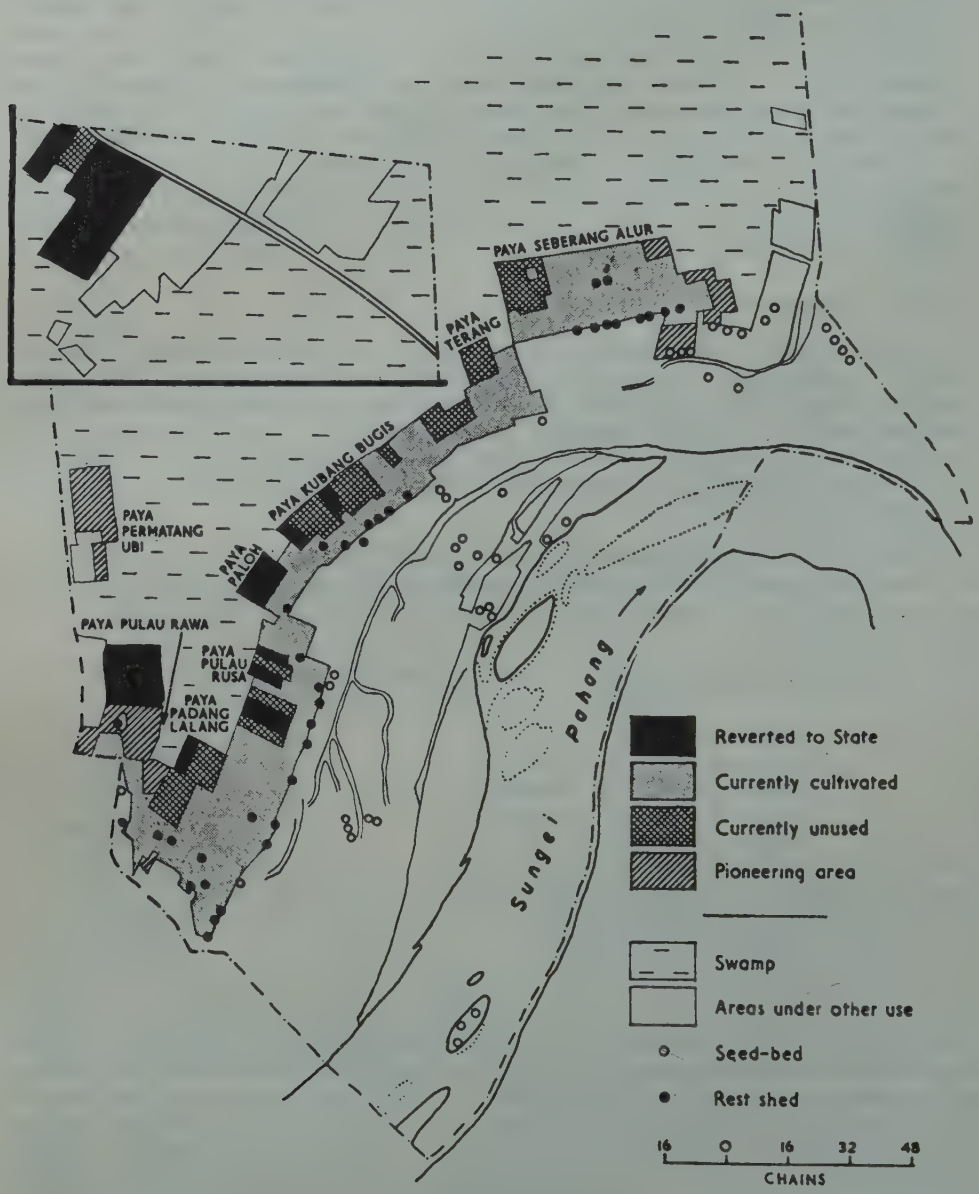


Fig. 10. Padi areas as mapped, August 1956. Inset: Ubai area.

results in the need for a second nursery crop consequent on the ageing of the initial one, and this in turn delays the date of transplanting.

Second, if it were possible to follow the official schedule, the critical period of flowering and seed formation would occur in November. The farmers claim that there is a high probability of losing the entire crop in the event of heavy rain during this critical month and follow a cycle whereby padi is transplanted about late July and August and harvested about late January and February with the recession of the flood-waters. It is maintained that on this schedule the floods are more likely to come after the critical flowering season and that consequently there is a much higher probability of a better harvest than that usually obtained by following the official schedule.

Third, there are certain economic and social considerations which make it difficult to maintain a strict schedule. Some peasants claim that the Puasa[1] month interrupts work in the fields. It is, however, maintained in official circles that if the schedule is strictly followed this period should coincide with the slack season following the planting of seed-beds. The inability of the workers to keep to schedule is also due to the prevailing system of mutual self-help (*bĕrderam*). As many as 54 of the 123 households working padi relied on bĕrdĕram in preparing their fields. In view of this reliance on others it is inevitable that the stages of work on the fields progress unevenly. This difficulty could be overcome by hiring labour, but not many cultivators can afford to do so. Wage rates for preparing one square chain of paya vary between $9 and 16 depending on the processes employed, and only five households reported hiring labour. Furthermore hired labour is not easily obtainable. Padi cultivation under present conditions is extremely hard and unattractive work. All work is manual. Even if a tractor were made available there is little prospect of it being put to efficient use on these small holdings where man has little control over the water-supply. In certain instances buffalo are used for part of the field preparation. Many cultivators, however, do not own buffalo and have to obtain them from the thirty-five that do. It costs about $20 to hire 3 buffalo to work one acre of padi-land. Only 19 cultivators were in the fortunate position of being able to obtain buffalo free of charge.

Finally it must be remembered that there is little enthusiasm for padi cultivation. Apathy, fatalism and the prospects of other avenues of employment, particularly rubber-tapping, are among the factors contributing to this situation.

*Field Processes*

(i) *Seed Beds.* The cultivation of 'wet' nurseries, that is, the use of sections of the paya itself, is not practised in the Mukim. 'Dry' nurseries are preferred since 'wet' nurseries are considered impracticable on account of the difficulty of water control and the high losses due to birds and other pests. 'Dry' nurseries are on small patches of crudely fenced ground, located chiefly on the drier fringes of the paya in the shade of rubber trees, tall grass or shrub. A few nurseries were also found near the dwellings, along the river bank and also on the islands (Fig. 10).

In preparing a nursery the undergrowth is first slashed with a *parang* (a long, broad-bladed knife), and then burned after being allowed to dry out for about a week. The parang is used again to disturb the soil and to cut up the roots

1. Period of daytime fasting observed by Malays.

left in it. Seed padi, usually from the previous year's harvest, is then broadcast and a thin layer of soil spread over the seeds with the aid of a *changkol* (Chinese hoe) in order to protect them from birds. Little attention is subsequently paid to the nurseries which are not watered even in the driest weather, the well-being of the young plants depending on the rainfall during June and July.

The principal varieties of seed used are *Sĕrĕndah, Mileh, Sarawak, Jamboi* and *Gansa Tĕmbĕling.* Of these five long-term varieties Sĕrĕndah and Mileh are the most popular. The popularity of these two, which ripen in about 7 or 8 months, depends on their higher production of shoots and their ability to withstand flood-waters. Sarawak, though giving good yields, needs ten months to ripen and this increases the risk of losses through pests. Jamboi has the lowest proportion of shoots of the five varieties. The amount of seed padi used is variable and could not be accurately ascertained. About 4 gantangs[1] are reportedly required to provide seedlings for an acre of paya.

(ii) *Preparation of Fields.* In the preparation of the fields the men take on a greater part of the work. The plough is not used at all in the Mukim. The three methods by which a field which has lain fallow is prepared for cultivation are: (a) *tĕbas* (b) *lĕnyak* and (c) *tajak.*

The word *tĕbas* in Malay means "to clear small shrubs or undergrowth." Two implements, the *pungait* (hooked stick) and the parang, are used alternately to hook and slash the undergrowth, which consists mainly of tall grasses such as *mĕnĕrong* (*Scirpus grossus*). This method, which attempts not only to cut down the undergrowth but also to pull out the roots, can be most effectively done where there is less than 6 in. of water. Unfortunately this is seldom possible and the incomplete clearing of the undergrowth partly accounts for its rapid regeneration along with the padi crop. After tĕbas has been completed the vegetation is left to rot in the stagnant water for about two weeks, after which it is collected and piled on the *batas* (bunds) to strengthen them. This process, called *rĕngai,* is necessary since the floating masses of incompletely decomposed vegetation are likely to choke the padi-crop later on. The practice of allowing the vegetation to rot in the field for a time before rĕngai is of doubtful value, since anaerobic decomposition makes the soils, which already have a high organic content, even more sour. It should be pointed out that on drier fields where this vegetation is left to dry and subsequently burned, yields are reportedly much higher.

The word *lĕnyak* in Malay means "to trample down," and in this method of field preparation buffalo are driven over a field to crush the undergrowth and churn up the top soil. This practice requires many hands to control the unyoked buffalo. The lĕnyak process is repeated after about a week to trample down any surviving undergrowth. It usually takes five buffalo about two weeks to work an acre of padi. Lĕnyak is more advantagous than the tĕbas method. Field preparation is expedited and the undergrowth is trampled deep into the soil and not allowed to decompose on the surface. There is consequently less anaerobic decomposition than that resulting from tĕbas. Cultivators claim that the lĕnyak method gives a better aerated soil and that yields are usually 20 % higher than on a tĕbas field. Lĕnyak is, however, not employed as much as tĕbas for the following reasons. The ground suited to it is restricted. Lĕnyak cannot be done effectively on dry fields or on fields with more than one foot of water. Furthermore, many cultivators do not own buffalo and often experience difficulty in hiring them or getting them free of charge.

1. One *gantang* = approximately 5 lb.

The tajak method, in which an implement with a six-inch blade fixed to a 4-ft. handle is used to turn both the surface soil and the undergrowth over, is rarely used in the Mukim. It requires soft ground but with not more than 2-3 in. of water, conditions which seldom prevail. As in the case of tĕbas, the uprooted undergrowth is subsequently piled on the bunds or burned on the fields.

(iii) *Transplanting.* Transplanting is done almost exclusively by the women. The seedlings are removed from the seed-beds by hand and are taken to the fields in rattan baskets called *ambong* and bamboo containers called *pengapit* which are carried strapped to the back. In transplanting the *kuku kambing* or planting-stick is not used as the soil is soft enough to be worked by hand. The usual practice is to place clumps of four to six seedlings about 9 in. apart from each other. In fields where the wastage is considered to be high, particularly in deeper areas, more seedlings are placed in each clump. On the few fields along the lêvée margin that are not saturated, a pointed stick about 6 ft. long and one inch in diameter (called a *tugal*) is used to stamp holes for the seedlings. In these fields rain is required within two weeks if the seedlings are to survive. Apart from infrequent visits to the fields to check on pests, little attention is paid to the crop after it is transplanted.

(iv) *Fertilizers.* No chemical fertilizers, compost or cattle manure are used in the padi-fields. Cultivators seldom complained of the soil being poor in plant nutrients. In any event a cultivator is likely to find the application of fertilizers uneconomical since the water does not remain static in a field for long.

(v) *Harvesting.* The harvesting of padi is usually done by the men and on most lots has invariably to be undertaken in standing water. During this season the rest sheds or *pondok* are of prime importance to the cultivator. Pondoks are small, stilted huts which also incorporate a wide, raised platform of wood and bamboo. This platform is used for drying and treading the harvested padi-stalks. Some families occupy the pondoks when the crop begins to mature in order to keep watch over it and stay on till after the harvest. Padi is harvested head by head with a tiny hand implement called the *tuai* and is dropped into a small basket called a *tankel* which the worker carries slung over the shoulders. In fields where the water level is high small boats are used to hold the harvested padi.

(vi) *Threshing and Winnowing.* The practice by which the grains of padi are separated from the ears is known as *irĕk.* It consists of placing the ears which have been sun-dried on the pondok platforms and trampling on them with bare feet. Winnowing by hand is carried out, preferably on windy days, either on the pondoks or in house compounds. A basket-tray called a *viru* is used to throw up the padi and chaff. After winnowing the padi is stored in the home in either gunny sacks, wooden boxes or wicker baskets. There are only two padi store-houses in the Mukim, a fact indicative of the low volume of production.

(vii) *Milling.* There are no padi-mills in the Mukim. Padi is pounded and dehusked, usually by the women, with the aid of hand-pounders called *lĕsong tangan* or by foot-operated pounders called *lĕsong kaki.* Small quantities of padi are milled by these methods from time to time to meet the normal rice requirements of a family. It takes about 1½ hours to mill 3 gantangs of padi in a lĕsong kaki. When large quantities of rice are required at one time, as for the Puasa month or for festivals, the padi is sent to the Government-operated mill in the neighbouring mukim of Pahang Tua.

*Productivity*

Estimates of padi yields per acre have little meaning since the variation in yields depends not only on the productivity of the soil but also on the incidence of

pests and on the degree of flood damage. A cultivator is seldom able to harvest the entire sown acreage. Crop losses due to pests are high and control of pests difficult on account of the high proportion of waste to cultivated land. Furthermore, the proportion of such losses is increased since all the padi does not ripen about the same time consequent on the staggered planting dates, and birds and rats in particular are able to concentrate on each plot as it ripens.

Of the 162 households in the Mukim, 116 indicated that most crop damage was caused by rats. Other pests reported were birds, wild boar and insects, among which were; *kutu běruang* (*Scotinophara coarctata*), *pianggang* or padi-fly (*Leptocorisa acuta*), *ulat gading* or stem-borer (*Schoenobius incertellus*), *bělalang* or grasshoppers and *ulat ratus* or caterpillars. Various traps and poisons are used to combat rats in particular. The use of poisons is, however, innocuous since the cultivator has little control over water levels in the field. Furthermore, if it were possible to alternately flood and drain the fields many of the smaller insect pests could be dislodged quite easily.

The highest yield per acre ever reported was about 300 gantangs and the lowest in the region of 30 gantangs per harvested acre. On the average the yield reported per harvested acre varies betwen 100 to 150 gantangs, and the total production is highly variable from year to year. The production for the 1955/56 crop season was estimated at 21,565 gantangs from 421 acres reportedly sown. The average yield per sown acre was thus only about 51 gantangs. On the basis that one adult requires approximately 10 gantangs of padi per month and that two children require the same quantity, it was estimated that the 1955/56 production in the Mukim was sufficient for only four months at the most. Only 32 of the 123 households working padi-land in the Mukim reported their production as being sufficient for from 7 to 10 months. Of the remainder, 60 declared their production sufficient for from 4 to 6 months and 31 for under 4 months. There is no trade in home-grown padi. Deficits are usually made good by purchases of rice from Pěkan.

*Pioneering*

Despite the very unreliable conditions of padi cultivation there is a demand for padi-land. For example, of the 110 AA. lots officially approved during the period 1950-56, 39 lots covering 117·25 acres were for padi. In addition 15 lots covering 40·13 acres were alienated as EMR. lands in the same period and there were also 5 applications for 6·8 acres under consideration in August 1956. The important point here, however, is that this pioneering has not resulted in a progressive or marked increase in the padi acreage. The new lands have merely replaced those lying unused or those which have from time to time reverted back to the State (Fig. 10). Most padi-lots have been abandoned or reverted to the State not because of the inability of the peasant to meet land rents but because productivity has supposedly declined. This decline is due not so much to a loss in intrinsic soil fertility but to the inability of the cultivator to adapt his techniques to meet changes in the composition of the soil and in the hydrography. For example, the continued use of a field tends to make the soils more sour each year on account of the high rate of anaerobic decomposition of vegetation that is evident at present. Again, water levels and lines of drainage in fields are bound to alter as the existing batas are built up or when new ones are constructed. A field on which lěnyak was previously possible may consequently become either too dry or too boggy for this type of field preparation which reputedly gives the best results. It is equally valuable at this stage to repeat the fact that the plough is no longer used in the Mukim. The older peasants claim that it was in use

before the flood of 1926 and consider its present demise merely as a lost art. It could well be that the plough was abandoned after 1926 because this primitive wooden implement could no longer be used in the deeper swamp area in which padi is now grown. The unsystematic pioneering carried out in the paya at the present time has many of the attributes of shifting cultivation. It can in no way be considered a movement leading to the methodical conquest of the paya and one which will result in a progressive expansion of the padi acreage.

## RUBBER CULTIVATION

Rubber cultivation was reportedly known in the Pĕkan District at an earlier period, but its introduction into the Mukim is said to have begun in the year following the flood disaster of 1926. The flood is reputed to have destroyed the greater part of the fruit, coconut and dry padi on the higher ground around Kampongs Tĕlok and Pulau Rusa and also to have enlarged the lêvées. Padi growing was also disorganized since most of the buffalo were lost and also on account of changes in the hydrography. The people on their return to the Mukim were quick to plant rubber, whose value as a highly remunerative crop they had begun to appreciate even before the flood. The seedlings used at first are said to have been obtained, at a cost of $9 per 1,000, from Chinese cultivators who had settled in Ganchong and who had correctly anticipated the demand. It is reported that by 1930 most of the available high ground was under rubber. Since that time rubber cultivation has been pushed into marginal bottom-lands and these trends are evident even today.

### *Ownership*

Of the 162 households in the Mukim, 92 between them owned 495·2 acres of the total rubber extent of 603·79 acres. The remaining 108·5 acres were owned by absentee landlords. The fact that 70 households did not own rubber-land does not detract from the importance of rubber in the economy of the Mukim, since 126 households claimed they earned a livelihood from tapping rubber. Of the remaining 36 households who did not claim to do so, 11 owned rubber land. It is also of note that wage rates in the Mukim for casual labour are geared to that which a rubber tapper is likely to earn, namely, $1.50 per morning.

Owner-worker relationships in rubber cultivation are even more complex than in padi-planting and are difficult to determine for the following principal reasons.

(i) An owner may rent, on a cash or share basis, either part or all of his holding. The duration of such agreements are variable and more than one household or one person may claim to have rented a given holding at different periods through the year. This latter complexity does not arise in the case of padi.

(ii) An owner may himself tap that part of his holding which has not been rented or may hire labour for the purpose. He may himself also work as a paid tapper or share-cropper on other holdings. In padi-planting, though one owner may work on land belonging to another, he usually does so in accord with the mutual self-help system, and this does not affect cash incomes or influence the distribution of the product as it does in the rubber economy.

(iii) The number of tappers and the periods for which they are employed are difficult to determine as written records are never kept. Tappers are often not only helped but even relieved of their work for considerable periods by members of the family or by friends. Discrepancies in the verbal replies given by landowners as to the number of tappers employed and the number of persons

who claim to be tappers are therefore inevitable. These complexities are less evident in padi-planting as there are fewer wage-earners.

*Productive and Unproductive Extents*

Of the total rubber extent of 603·79 acres, nearly 381 acres consisted of mature trees, 175 acres of trees yet untapped and about 47 acres were in the pioneering stage (Fig. 11). The greater part of the mature rubber was in the areas adjacent to the kampong zone. Peasants claimed that rubber could not be

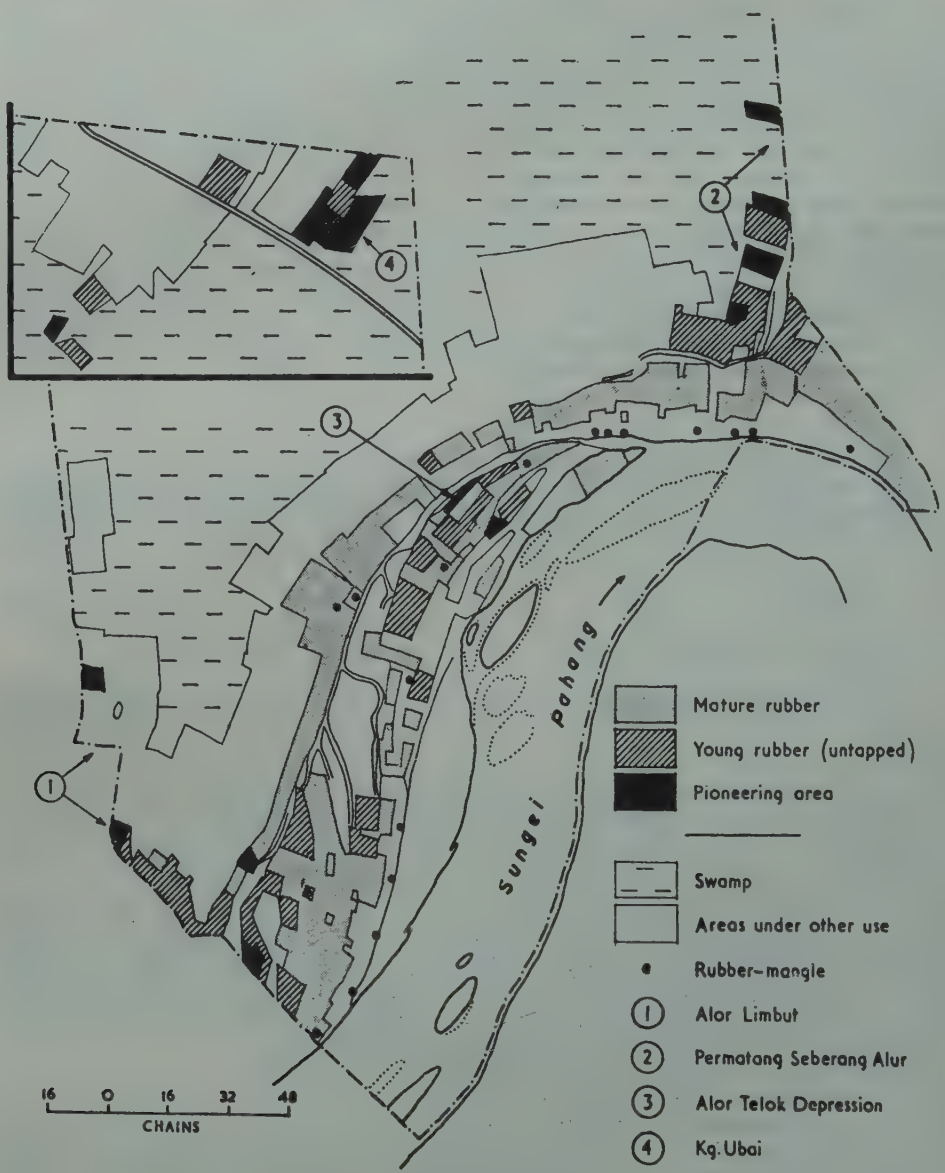


Fig. 11. Rubber areas as mapped, August 1956. Inset: Ubai area.

grown successfuly where the water-table was closer than 2 ft. from the surface, but in their enthusiasm for a more rewarding crop than padi this critical limit had been passed. Much of the 175 acres of rubber that was yet untapped was on ill-drained ground where there was little prospect of worth-while returns being obtained. In these areas many trees were between ten and fifteen years old, but their development had been so retarded that they had the appearance of not being more than from three to five years old. The assertion that rubber has been pushed beyond its critical limits is further substantiated by the fact that padi is now grown on lands previously cultivated with rubber. For example in the Kuban Bugis area of the paya (Fig. 10) the stumps of rubber trees still stand amidst the padi.

*Tapping*

On owner-operated holdings the tapping is done by the owner and members of his family, including even young children. When required, additional labour is sometimes obtained at the rate of $1.50 per morning. On other lands the following two systems of tenancy, one on a share-cropping basis and the other as rent, are customary.

(i) *Share-cropping or bagi dua.* In this system which is on a day-to-day basis, the owner supplies all equipment including the tapping knife, pails and coagulant. The share-cropper taps, collects the latex and processes it into sheets. The output for the day is then shared equally between the owner and the tenant. The share-cropper is also entitled to the scrap-rubber, which is often as much as two katis[1] for a four-kati latex crop, on payment of only 25 cents per kati.

(ii) *Renting of land or guta pajak.* In this system the tenant rents the land on a monthly or yearly basis by making a down-payment in cash. The amount paid is usually only two-fifths of the value of the estimated yield as there is a considerable element of doubt as to whether the estimated yield can be realized. Guta pajak agreements are usually on a monthly basis because the would-be tenant requires less capital and also because estimates of yields are easier, safer and less likely to compromise either the owner or the tenant. Furthermore, on monthly agreements the owner finds it easier to supervise and ensure proper tapping whereas he is powerless to exercise his authority over a year. Guta pajak agreements even on a monthly basis, are far less common than bagi dua and are usually entered into only when a landowner is in dire need of ready cash or when he is forced to pay an outstanding debt—the creditor being given rights of tenancy and the debt discharged in small instalments.

*Production*

Yields, though seldom uniform between different holdings or sustained through the year, can be summarized as follows on the basis of eighteen to twenty days tapping per month.

(i) Trees from kampong seedlings: 3 pikuls[2] per acre per year.

(ii) Trees from clonal seedlings: 6-8 pikuls per acre per year.

(iii) Trees from bud-grafts: 12 pikuls per acre per year.

1. One *kati* = 1⅓ lb.
2. One *pikul* = 100 katis or 133⅓ lb.

The greater part of the production is as yet obtained from holdings planted with kampong seedlings. Few holdings in the Mukim cultivated with clonal seedlings or bud-grafts have yet reached maturity. The total production for 1955 was estimated at 835 pikuls or an average production of about 2·2 pikuls per acre of mature trees. This is below the estimated optimum yield per acre of kampong trees. The low yields obtained can in large part be attributed to the following reasons. Many trees have passed their prime or have been ruthlessly slaughter-tapped. Little care is devoted to the holdings and no fertilizers are used. Finally tapping methods also leave much room for improvement.

*Processing and Disposal of the Product*

In processing the latex about half a kati of concentrated coagulant is required for one pikul of rubber. The coagulant costs about 60 cents per half-kati in Pĕkan but is also available in the Mukim shops at 70 cents. The latex is allowed to coagulate in pans, usually made from old kerosene tins, for about 45 minutes. The wet sheet-rubber is then passed through hand-operated rollers or mangles. These mangles are available in Pĕkan and Kuantan at between $140 and $160 each and are purchased by groups of peasants in partnership. There are only 18 mangles in the Mukim (Fig. 11) and as many as 14 persons are known to share one.

In their desire for quick cash the majority of the producers merely sun-dry the rolled, wet sheets for two or three days before selling their product in a semi-dry state to either the single licensed rubber-dealer living in the Mukim or directly to dealers in Pĕkan. In so doing they lose an opportunity of obtaining a higher income since semi-dry rubber fetches a lower price. Furthermore, if the peasant were not only to dry but also to smoke the sheet his profit margin would be even greater. There are, however, only two smoke-houses in the Mukim, one of which is owned by the rubber-dealer and the other by a peasant producer.

About half the Mukim production goes through the rubber-dealer who claims to purchase some 30 to 40 pikuls per month. He is seldom able to obtain No. 1 quality R.S.S. More of the No. 1 quality could be had if the producers were to employ greater care in filtering the latex and in using the right proportion of coagulant. The dealer sells the smoked rubber in Kuantan. His profit margin here is greater than at Pĕkan. The rubber is first transported by boat to the roadside via either the Pahang or Pahang Tua, at a rate of 50 cents per pikul, and thence to Kuantan by lorry, at a rate of 80 cents per pikul. The dealer claims to make a profit of about $90 per month from this trade.

*Replanting of Rubber*

Though the need for replanting much of the older rubber is an obvious one, there is little evidence of an effective programme of replanting as yet. Most small-holders are reluctant to undertake replanting since it means that they will be without an income for at least six years until the new rubber reaches maturity. The Government Rubber Replanting Board has attempted to meet this consideration by instituting a scheme of financial assistance. The principal conditions of this scheme are as follows:—

(i) Applications for the replanting of not less than one acre are approved only after details of ownership and land use recorded in the official registers have been verified and after the land has been declared suitable for replanting.

(ii) After these preliminaries the peasant is required to fence, clear and prepare his holding to the satisfaction of the authorities before receiving an initial grant of $200 per acre.

(iii) Clonal seedlings and fertilizer are then made available, the cost of these being usually deducted from subsequent grants. Planting operations are scheduled for September.

(iv) Provided that progress has been satisfactory there is a further grant of $100 per acre six months after the commencement of replanting. It is required that about 180 seedlings per acre should be well established. In the event of this standard not being reached on account of circumstances deemed to be beyond the peasant's control, he is entitled to a compensation of not more than 15% of the due instalment.

(v) A final grant of $110 per acre is made in the following year if progress continues to be satisfactory.

Only one small-holder in the Mukim has so far replanted a three-acre lot under this scheme. Two more have applied for assistance but have not commenced replanting. This limited response can be associated with the following considerations:—

(i) Many peasants own less than one acre and cannot, therefore, claim assistance under the scheme.

(ii) Even those owning more than one acre are reluctant to replant their holdings since there is a strong element of doubt as to whether they can meet the requirements laid down by the authorities.

(iii) There is a very high probability of all efforts at replanting being negatived by the annual floods.

(iv) Many farmers claim that they require financial aid to start clearing and fencing their land.

(v) Much rubber is grown on land originally alienated for padi or kampong crops. On their seeking assistance under the scheme many landowners will have to pay higher land rents.

*Pioneering*

Though much of the young rubber already planted in the Mukim has failed to develop satisfactorily, the demand for new rubber-land continues. For example, of the 110 AA. lots approved during the period 1950-56, 45 lots covering 153·13 acres were for rubber. In addition 10 lots covering 26·97 acres were alienated as EMR. land during the same period and there were also 17 applications for 41·93 acres under consideration in August 1956.

Pioneering is usually on land occupied by gĕlĕgah, bĕlukar or forest. Methods are haphazard, the land being cleared as for shifting cultivation. A food catch-crop is normally obtained from the land before it is planted with rubber. Seedlings are obtained from the Government Agricultural Station in Pĕkan at a cost of $15 per 100 seedlings. These are made available in September but planting is held over by many peasants till after the monsoon, since it is considered that the seedlings will then have a better chance of surviving. This delay in planting is, however, likely to affect the quality of the crop. After planting little attention is paid to the land apart from the infrequent clearing of lalang and other grasses.

There are 4 main pioneering areas at the present time (Fig. 11). (i) The Alor Limbut area alongside Mukim Ganchong. (ii) The Pĕrmatang Sĕbĕrang Alor alongside Mukim Pahang Tua. (iii) The Alor Tĕlok depression inland of

Kampong Tĕlok. (iv) The Kampong Ubai area. In the first three areas the land is liable to flooding during the rainy season and the soils are poorly drained. In the Ubai area the soils are inclined to be slightly saline. It is unlikely that pioneering in these four areas will prove entirely successful.

## COCONUT

Of the 113·5 acres estimated to be primarily under coconut, 51·44 acres consisted of fully established trees and 66·06 acres of recent plantings where tapioca and other foodsuffs were also inter-cultivated with the coconut seedlings. In addition, there is much coconut grown on kampong land.

A precise estimate of productivity is difficult since picking is unsystematic and also because much of the produce is for immediate local consumption. The total production for 1955 was estimated at about 74,000 nuts. One interesting feature is that monkeys have been trained to do the picking.

There are 9 copra kilns in the Mukim, of which 8 are in Kampongs Tĕlok and Pulau Rusa and one in Ubai. The kilns are operated by local shopkeepers who either buy their supply of coconuts from the peasants or obtain them by barter. The copra is sold to dealers in Pĕkan. In the absence of written records, no estimates of copra production can be made. The production fluctuates considerably since the supply of nuts is seldom constant and also because the owners operate the kilns only when the market price for copra leaves a worthwhile profit.

## LIVESTOCK

The numbers of livestock and their distribution among the 162 households in the Mukim are as follows:—

| | TOTAL NUMBER | NO. OF HOUSEHOLDS OWNING LIVESTOCK |
|---|---|---|
| BUFFALO | 128 | 35 |
| SHEEP | 266 | 37 |
| GOATS | 61 | 11 |
| FOWLS | 1,875 | 154 |
| DUCKS | 183 | 36 |

The livestock economy is an indifferent one despite the importance of buffalo in padi cultivation and the significant contribution made by all livestock to the food supply and to the cash incomes of the people. The principal difficulty with regard to buffalo-rearing is the restricted area available for grazing. The paya is not used for grazing during the fallow season on account of the damage done to the batas. Indian dealers from Kuantan, Pĕkan and also from Tĕmĕrloh call frequently to purchase goats and sheep for slaughter. These animals fetch between $20 and 25 each. Fowls and ducks are traded in Pĕkan by the peasants themselves or are sold to the Chinese dealer who visits the kampongs at least once every fortnight.

## FISHING

Fishing in the river, alors and even the paya with the aid of traps, hand-nets or lines is a common and important occupation. The catch, however, seldom meets local requirements. Much sea fish has to be bought from Pĕkan.

## OTHER ACTIVITIES

Miscellaneous activities include the gathering and sale of rattan and the making of cane baskets, straw mats, thatching materials and other allied products for use in the homes. There are no cottage industries of economic significance in the Mukim.

## INCOMES

The average cash income per month was estimated at $65 per household. Only 46 households had incomes greater than this average and of these households 14 had incomes ranging from $120 to a maximum of $351 per month. Persons within this higher income group were the Government employees, school-teachers, shopkeepers and boatmen.

## STATE AID

State aid for economic development has been limited to the following principal measures.

(i) Loans and supply of materials for rubber replanting.

(ii) Loans for purchasing buffalo.

(iii) Loans by the Rural Industrial Development Authority to individuals and grants for public utilities.

(iv) A short training course at the Pĕkan Agricultural School.

So far only three persons have sought assistance for replanting rubber, and only 12 persons have taken loans, in the period 1950-56, for purchasing buffalo. RIDA has financed the building of a well and the construction of the wooden footway (already in a state of desrepair) across the alor behind Kampong Tĕlok. Only nine men, all under twenty-one years of age, have been to the Agricultural School. None of them own land and they have had little opportunity of using the knowledge gained at the school.

## CONCLUSION

There is scope for increased productivity on the present-day cultivated extents. On the kampong lands in particular much ground could be cultivated more fully with vegetables and other food crops. With better husbandry more benefit could also be obtained from livestock. Even if the people were to respond more readily to the task of improving agriculture through a more diligent application of labour than at present and also by taking fuller advantage of the available Government assistance, it is unlikely that their efforts would result in a sustained improvement of the economy. Until such time as a comprehensive scheme for water control and land reclamation is implemented, the population will be at the mercy of the elements and continue to live in a state of insecurity.

# VARIABILITY OF RAINFALL IN QUEENSLAND

By ROSS S. DICK

The varying character of rainfall more than any other climatic feature is responsible for the main regional differences in climate in Queensland. In contrast to temperature patterns, those of rainfall (for example, amounts received in a given period, variability and intensity) often exhibit conspicuous, large-scale and abrupt changes in distribution. The most pronounced contrasts in rainfall character are largely confined to the eastern and northern coastlands, within 50 miles of the sea.[1] Farther inland transitions are very much more gradual. Moisture conditions range from highly humid to extremely arid. Queensland rainfall is particularly notable for its moderate to high variability; substantial positive deviations from standard world values are recorded at all stations.

In what follows, the patterns of annual and seasonal rainfall-variability are discussed, and some of the more important consequences of the variability factor are described.

## RELATIVE VARIABILITY OF ANNUAL RAINFALL

The rainfall records for 220 stations were studied (Fig. 2A) and the deviation of each year's total from the mean noted.[2] The average deviation was then determined and expressed as a percentage of the average rainfall. The main spatial differences in relative variability are indicated in Fig. 3B. The widespread occurrence of moderate and high values is clearly established. Over 60% of the state has average annual variabilities greater than 30%. On the other hand less than 2% of Queensland records values of less than 20%.

| *Relative variability* | *Percentage of total area of Queensland* |
|---|---|
| Less than 20% | 1·4 |
| 20 - 25% | 21·3 |
| 25 - 30% | 15·5 |
| 30 - 35% | 23·2 |
| 35 - 40% | 17·6 |
| 40 - 50% | 12·2 |
| Greater than 50% | 8·1 |

There are four areas which experience low relative variabilities, that is, less than 20 per cent:

(i) Northern Cape York peninsula;

(ii) tropical north-east coastlands centring on Innisfail;

1. For example Babinda, 35 miles south of Cairns, on the exposed tropical north-east coast records an average annual rainfall of 162·5 in. whereas Mareeba, farther inland, and only 50 miles distant from Babinda receives 35·2 in. In the 'dry' season, May-October, inclusive, the respective totals are 41·1 in. and 2·5 in. The average annual variability of rainfall at Babinda is 16·4%; at Mareeba 27·7%.

2. Only stations with records of 30 years or longer have been included in the survey. Source data was gained from *Results of Rainfall Observations made in Queensland,* published by the Commonwealth Bureau of Meteorology, Melbourne, 1940.

(iii) the southern Darling Downs near Warwick;

(iv) the southernmost portion of Queensland, near Stanthorpe and adjacent to the Queensland-New South Wales border.

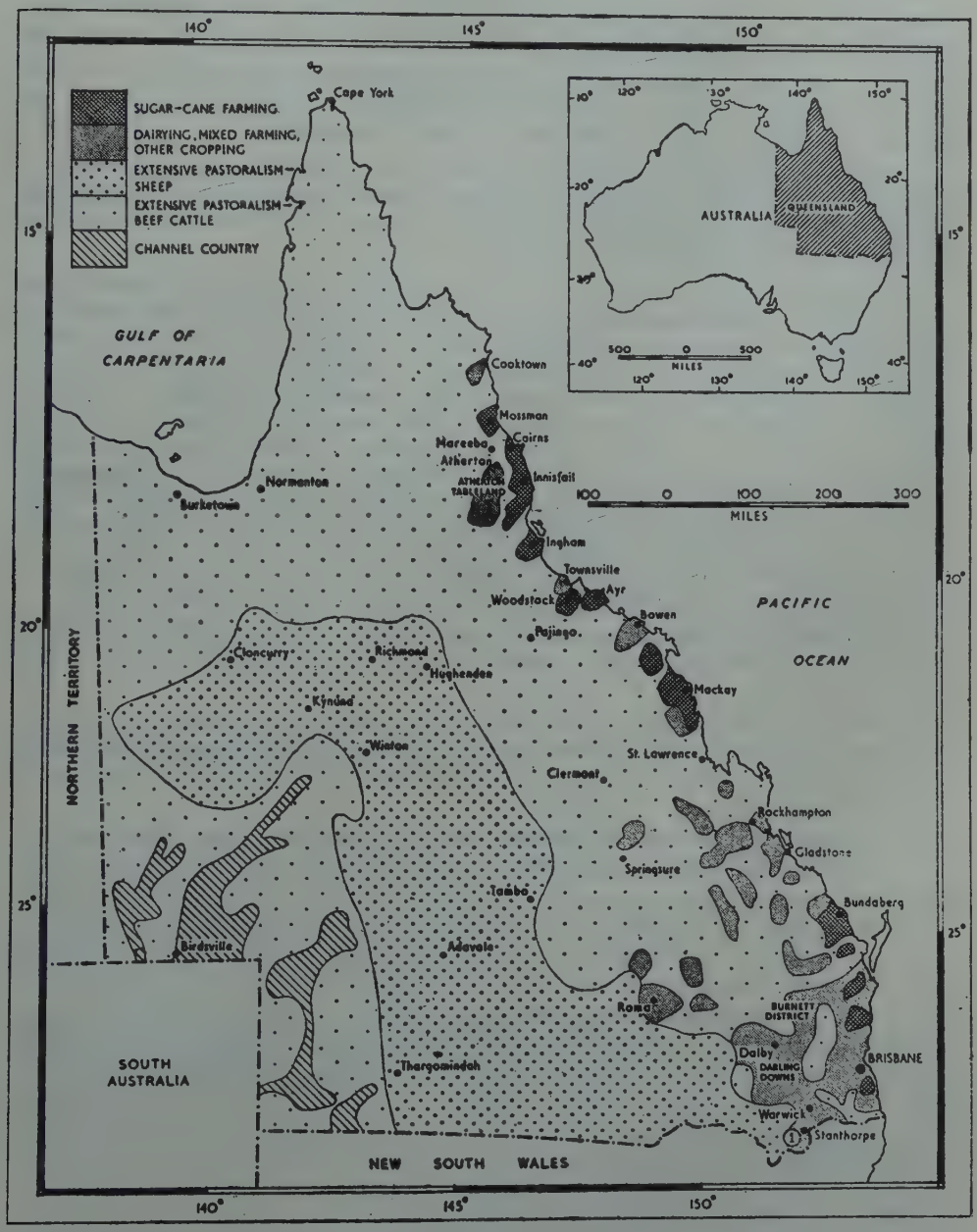


Fig. 1. Location map showing (i) place-names mentioned in the text and (ii) main forms of rural land use. The granite belt of the south-east is denoted by the numeral 1 enclosed in a circle.

The distribution of low relative variabilities in North Queensland coincides with areas receiving the highest rainfall totals. This is a normal relationship. And it is usual also for variability values to increase as rainfall totals decrease. In view of this the two low variability areas in South-East Queensland are especially noteworthy as they represent an important departure from this general rule. In spite of a substantially lower average rainfall, the inland districts of the Darling Downs and the Granite Belt register lower average relative variabilities than coastal lands.

Two compact and extensive areas experience moderate variabilities of 20-25 per cent. These are located in the northern and southern extremities of the state—the peninsular country and south-eastern Queensland.

The transition to areas with variabilities greater than 30 per cent is achieved rapidly south of the peninsular country, whereas inland from South-East Queensland the change is much more gradual. Rainfall totals for the two areas concerned exhibit a comparable difference in rate of transition.

With the important exception of south-eastern Queensland, noted above, coastal areas normally experience lower rainfall variabilities than sub-coastal and inland districts. However, prominent regional differences in variability occur along the Queensland coast. The area from Bundaberg north to Townsville is especially notable. With few local exceptions[1] variabilities exceed 25 per cent, while north of Bowen, almost to Ingham, values exceed 30 per cent.[2] The most noticeable feature about the pattern of isopleths in inland areas with high variabilities (i.e., greater than 30%) is the persistent occurrence of a wedge-shaped extension of high values towards and to the coast in Central Queensland. While this trend is also evident in the annual rainfall isohyets it is much less pronounced.

All stations studied exhibited substantial positive anomalies in respect of relative variability, when compared with standard world values[3] (Fig. 3C).

Only 4% of Queensland registers anomalies less than +30%, while 80% of the state has anomaly values exceeding +50%. The following points are also worthy of note:—

(i) Several areas of high rainfall record high positive deviations from world standard figures. For example, stations in the Cairns-Ingham coastal strip, with annual totals ranging from 80-90 in., have variability anomalies of 60-80 per cent.

(ii) Stations in the Cocktown-Ingham coastal strip register higher anomalies than coastal stations south of Bundaberg, which have substantially lower rainfalls.

(iii) Two east-coast areas possess average variabilities more than 80% higher than world norms. These are (a) the Bowen-Townsville coastal area, and
(b) the coastal area near and immediately north of St. Lawrence.

(iv) An inland area in south-eastern Queensland, embracing the Darling Downs and the central and upper Burnett districts, has substantially lower deviations in variability than the higher-rainfall districts lying to the east.

(v) A comparable trend to the one noted in (iv) above, but on a much smaller scale, is found between stations on the Atherton tableland and the adjacent coastlands.

1. The value for Mackay is slightly below 25%.
2. e.g., Townsville 30·4%; Ayr 35·1%.
3. After V. Conrad and L. W. Pollack, *Methods in Climatology* (Cambridge, Mass. 1950), Chapter 2.

(vi) The pattern of isopleths confirms the presence of a broad wedge of abnormally unreliable rainfall thrusting coastward north-east from Winton and Pajingo even to Townsville and Ayr.[1] A secondary extension of a similar kind is evident near Clermont.

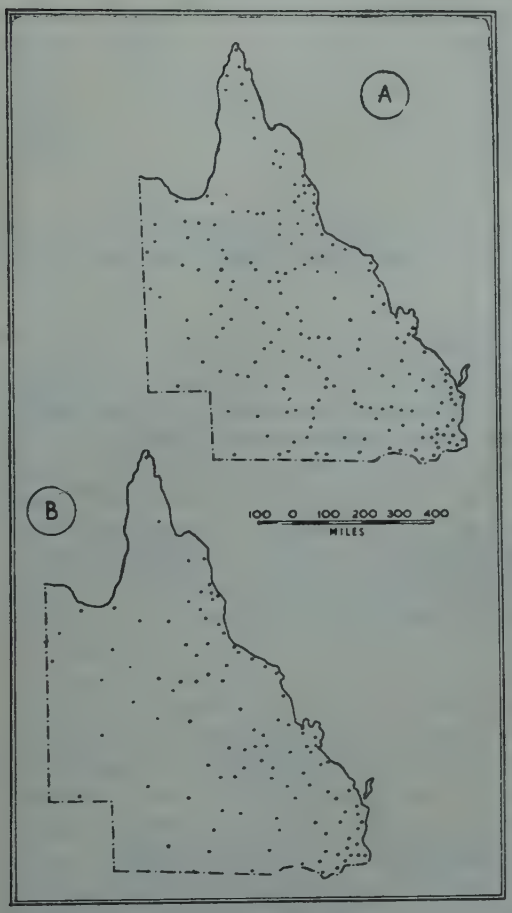


Fig. 2. Queensland.
A. Location of climatic stations used in plotting relative variability of annual rainfall.
B. Location of climatic stations used in plotting relative variability of seasonal rainfall.

The spatial variations in relative variability which have been noted above appear to be closely related to the character and movements of air masses in and near Queensland. The moderate to high variability values in eastern coastal areas are partly explained by the irregular occurrence of tropical cyclones. Rimmer, Hall and Hossack have drawn attention to the variable but commonly occurring local instability rains in coastal areas.[2] The abnormally high incidence of thunderstorms in coastal districts of south-eastern Queensland also contributes to the irregular and uncertain character of rainfall here.[3]

The wedge-shaped salient of outstandingly variable rainfall in Central Queensland occupies a position which is marginal to the main areas of influence of rain-yielding airmasses in summer and winter. It normally lies beyond the southern margin of reliable rain-producing tropical air masses which enter north-eastern Queensland in summer. And in winter the area usually lies too far north to benefit appreciably from rain-yielding air masses which enter southern Queensland and move north-eastwards.

## RELATIVE VARIABILITY OF SEASONAL RAINFALL

Few areas of comparable size in the world possess such a strongly seasonal incidence of rainfall as does Queensland (Fig. 3D). Most of the state experiences a marked concentration of rainfall in the summer half-year; the proportion varies from 60% in the extreme south to more than 95% in the Gulf country[4] and Cape

1. Positive anomalies at Townsville, Woodstock and Ayr are 88%, 106% and 119% respectively.
2. T. Rimmer, K. N. S. Hall, and A. W. N. Hossack, "An Analysis of Queensland Rainfall (1925-1936)," *University of Queensland Papers, Department of Physics*, vol. 1 (Brisbane, 1939).
3. Many stations record 60-80 thunderstorms per year.
4. This term refers to land drained by rivers entering the southern portions of the shallow Gulf of Carpentaria.

York Peninsula. A study of annual rainfall graphs in most instances reveals a distinct increase in rainfall beginning in November, and a definite decrease from May onwards.[1] The variabilities for the 'wet' and 'dry' seasons were calculated for 120 stations (Figs. 2B, 4B and 4D).

During the 'wet' season the least variable rainfall (with values less than 30%) occurs in the following areas:—

(i) inland south-east Queensland—notably the Darling Downs;

(ii) the Cocktown-Ingham coastal strip;

(iii) Cape York Peninsula.

The central eastern coastal and sub-coastal lands are distinguished by having notably more unreliable rainfall. Two areas have values higher than 40%:

(i) the lower Burdekin district near Ayr; and

(ii) the sub-coastal area between Rockhampton and St. Lawrence.

In Central Queensland wedges of unreliable rainfall extend coastward to Ayr in the north and to the neighbourhood of Clermont and Springsure in the south. 'Wet' season rainfall variability does not vary consistently with changes in total rainfall received. For example, in areas receiving 20 in. the variability values range from less than 25% to more than 40%. A similar range in variability is true of areas recording 15 in. In the 'dry' season, too, changes in variability (except locally) are largely independent of differences in the amount of rainfall received (Figs. 4C and D). However, the basic regional differences, noted in the annual and 'wet' season variability patterns, are repeated in the 'dry' season.

## SOME GENERAL CONSEQUENCES OF RAINFALL VARIABILITY IN QUEENSLAND

With very local exceptions, all of Queensland experiences a moderate to high variability of rainfall; everywhere values are substantially higher than world averages for stations with similar rainfall totals. One example of the widespread significance of this regime is evidenced in the often pronounced year-to-year or seaonal fluctuations in agricultural production and livestock numbers. The repercussions in an economy so heavily dependent on primary production are far reaching and often serious. Consequent upon the losses of stock and agricultural production, the purchasing power of the rural community is reduced. Sharp reductions in retail trade or processing industries, are keenly felt in urban communities. Governmental authorities, too, are directly affected by reduced taxation receipts. In many instances droughts or floods are the causes of over-riding importance. All types of agriculture in Queensland suffer to some extent from drought; most affected of the major forms of production are the sheep, beef-cattle and dairying industries and cereal growing. Sugar-cane farming is less often seriously affected in this way. The production of sugar-cane is concentrated mainly in those higher-rainfall areas of coastal eastern Queensland, with the least variable rainfall. One notable exception is the Lower Burdekin district, centring on Ayr, where, because of the highly unreliable nature of a

1. These two 6-month periods, November-April and May-October may conveniently be referred to as the 'wet' and 'dry' seasons respectively.

marginal rainfall,[1] irrigation is widely practised and considered indispensable for the securing of sustained high yields. In the few localities near Ayr where cane-growing is fully dependent on rainfall,[2] yields fluctuate widely.

In the Bundaberg district, where annual rainfall totals are only slightly greater than in the Lower Burdekin area,[3] sugar-cane is almost everywhere grown without irrigation. This reflects the higher winter half-year falls, and the less variable precipitation at all seasons. Nevertheless, substantially below-average rainfall is occasionally experienced in this and all other non-irrigated sugar-cane districts. And undoubtedly the employment of irrigation in all areas south of the Mossman-Ingham coastal strip[4] would result in much increased yields.

Drought-prone Queensland frequently experiences excessive rainfall and floods which also cause the failure of crops, loss of livestock, or serious declines in production. Wheat production in the Darling Downs area, for example, is adversely affected by higher-than-normal precipitation during November,[5] the time of harvesting. During the thirty-year period 1927-1956 excessive November rainfall has been registered at Warwick and Dalby on 15 and 14 occasions respectively. Above-average rainfall in June in the Mossman-Cardwell coastlands commonly causes a serious delay in the milling of the sugar-cane and is accompanied by a lowering of the sugar content in the cane. One of the major problems faced by the timber-milling industry on the adjacent uplands is the common but erratic recurrence of excessive rainfall, which forces a cessation of logging activities.

The critical importance of rainfall variability in this rainiest region of Queensland is also seen in the development of thermal electric power to supplement hydro-electric power output during times of low production. Dairy farming is highly vulnerable to fluctuations in rainfall, both annual and seasonal. Dairying is largely concentrated in south-eastern Queensland, where moisture conditions are among the least variable in the state. However, annual and seasonal variations in rainfall are substantial. Partly because of this, fodder conservation (mainly in the form of hay and stored grain) is commonly practised. Often fodder reserves are needed to maintain production during drought spells in the so-called 'wet' season of November to March.

A study of the minimum rainfall requirements of the dairying industry in the Moreton coastlands near Brisbane and in the eastern Darling Downs, reveals that less rain appears necessary in the inland situation. It is probable that the lower totals in the Downs area are compensated for in a small but influential way by the generally increased reliability of rainfall compared with that of the coastal dairying lands.[6]

1. The average annual rainfall at Ayr is 41·0 in.; the average annual relative variability is 35·1 per cent.
2. Of the 50,000 acres assigned to cane, 40,000 acres are recorded as irrigated.
3. Annual rainfall totals in the Lover Burdekin area range from 32-42 in., whereas in the Bundaberg area totals range from 40-45 in. per year.
4. Because of the high rainfall totals received in most parts of this district, substantially below-average falls are seldom injurious to the cane crop. During each of the last 25 years, raw-sugar yields per acre have been clearly highest in the irrigated Lower Burdekin area.
5. Some reduction in output is usual if 1½-3 in. of rain fall in November. Falls in excess of 3 in. are regarded as excessive, and normally cause substantial crop failure.
6. Efficient fodder conservation in the Darling Downs area safeguards production in years of low rainfall. In many coastal areas, fodder reserves are inadequate or lacking and consequently are seriously affected in dry years.

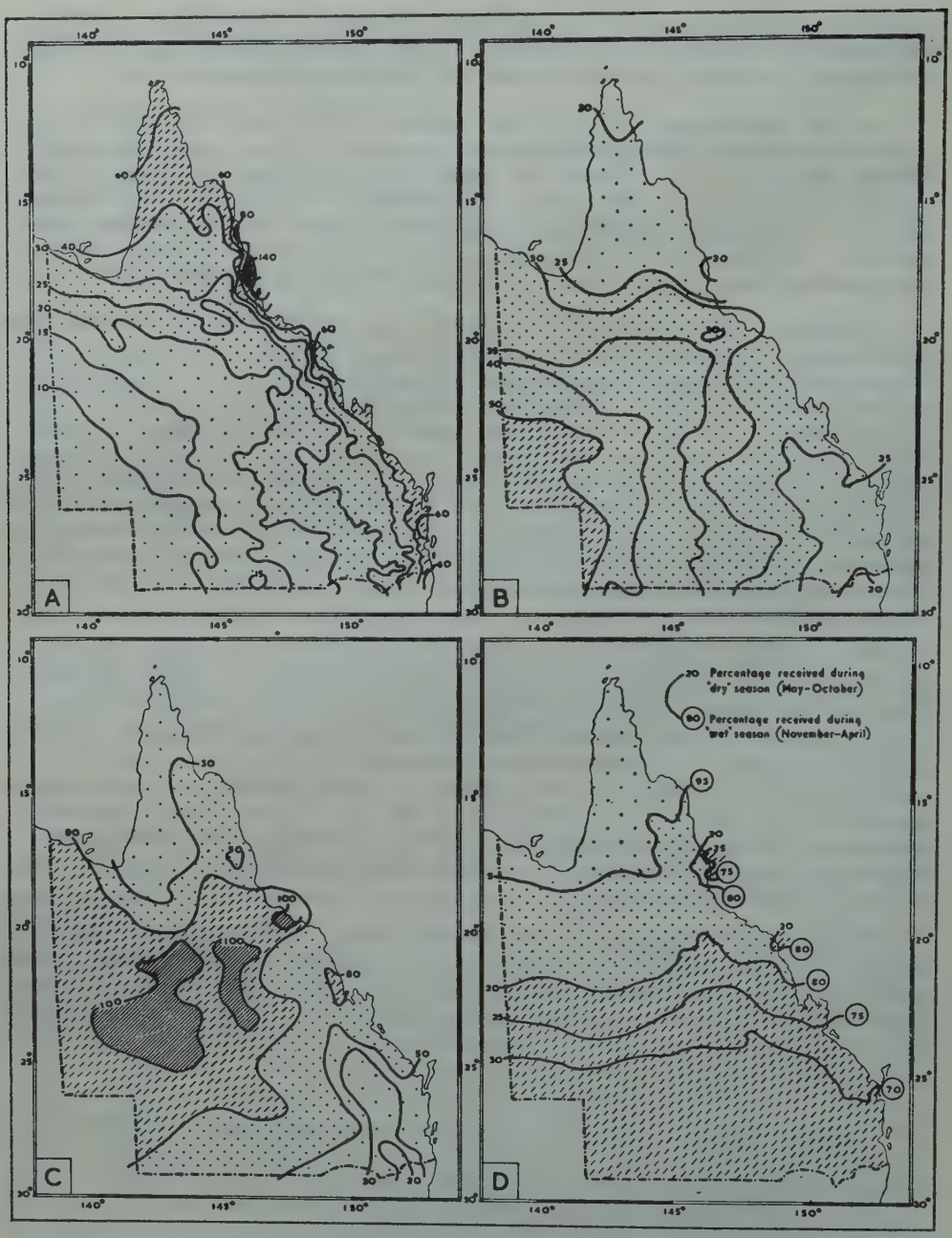


Fig. 3. Queensland.

A. Average annual rainfall (in inches).

B. Relative variability of annual rainfall (mean deviation expressed as a percentage of average rainfall).

C. Anomalies in relative variability of annual rainfall (expressed as percentage deviations from world standard values). All anomalies are positive.

D. Proportion of annual rainfall received during 'wet' and 'dry' seasons.

Although values of rainfall variability recorded in the Darling Downs are among the lowest in Queensland, they are none the less substantial, and everywhere higher than standard world values for places with comparable rainfall totals. A reminder of this fact is seen in the inability of Downs farmers to establish satisfactory permanent sown pastures. The low annual and winter half-year rainfall and its pronounced variability are the basic problems to be dealt with.

The widespread occurrence of irrigation in the moist coastal areas of Queensland—even where annual rainfall exceeds 40 in. — is a further consequence of moderate to high rainfall variabilities. In and near the Brisbane metropolitan area, facilities for spray irrigation are a conspicuous feature on nearly all market-gardening properties even though annual rainfall in these localities ranges from 40 to 55 in. The erratic nature of the rainfall in the fertile black-soil plains of the Lockyer valley, 30 miles inland from Brisbane, has made the use of irrigation essential, where continuous field-cropping is practised.[1]

The character of fruit- and vegetable-growing in central coastal Queensland, from Mackay to Gladstone, affords interesting evidence of the influences of rainfall variability. Facilities for irrigation throughout the area are poor. Underground water-supplies are either inadequate or unsuitable for fruit and vegetable crops, except on the alluvial plains along the Fitzroy River near Rockhampton. Hence, beyond this locality fruit and vegetable production is closely dependent on seasonal rainfall. The extremely variable annual output of tomatoes, the main horticultural crop, is a direct consequence of this. In recent years the area devoted to banana-growing has continued to decline, chiefly as a result of damage caused by a succession of droughts and occasional spells of hurricane-force winds. As King has pointed out, "although soil and most climatic factors are suitable for banana production, the rainfall is so uncertain that the industry is unlikely to become as important as it is in southern Queensland."[2] On the other hand the area planted to pineapples and papaws has expanded. This is significant because both crops are able to withstand dry seasonal conditions very well.

The success of crop agriculture in coastal areas between Bowen and Townsville is largely dependent on irrigation, in spite of the fact that the average annual precipitation exceeds 40 in. in most parts. The abnormally uncertain character of the rainfall at all seasons in this region is a basic cause of the limited extent of unirrigated cropland and the marked fluctuations in yield from such areas.

The Bowen-Townsville district suffers not only from drought as a consequence of high rainfall variability, but also from an occasional surfeit of moisture. Falls of more than 7 in. within a week occur on an average at least once a year. These falls cause serious waterlogging of soils and local flooding on irrigated land.[3]

It is significant that in eastern coastal districts where the relative variability of annual rainfall exceeds 25 per cent and where annual precipitation is less than 50 in., the raising of beef-cattle is areally and economically the most important form of land use. Soils over large areas are strongly podsolized and of low fertility status, facilities for irrigation are restricted, and costs of clearing the open-forest lands are high. However, a further important deterrent to the

1. Average annual rainfall totals in this area range from 25-30 in.
2. K. King, "Horticultural Districts of Queensland—Central Queensland," *Queensland Agricultural Journal*, vol. 76, no. 8 (August, 1951), p. 78.
3. For details see CSIRO, publication, *Survey of Townsville-Bowen Region, 1950, Land Research Series*, No. 2 (1953).

development of more intensive farming is the marked unreliability of the rainfall.

Commercial-crop agriculture in Queensland is largely restricted to eastern coastal districts. The notable exception, however, is the Darling Downs, the most extensive cropped-area in the state. Compared with other districts in Queensland experiencing a similar average annual rainfall, the Darling Downs has the following notable edaphic and climatic adventages:—

(i) the widespread occurrence of deep, fertile, humus-rich and moisture-retentive black soils;

(ii) a more substantial winter half-year rainfall; and

(iii) a less variable rainfall, both annually and seasonally.

The precise significance of the latter factor has as yet received little attention.

The climatic qualities referred to above are advantages only in the comparative sense mentioned. As stated earlier rainfall variability is pronounced by world standards.

The present high productivity of the area also owes much to man's ingenuity in countering the effects of an erratic rainfall, especially by adopting dry-farming methods, by developing or introducing drought-resistant varieties of crops[1] and by employing large-scale mechanization to enable planting and harvesting to be carried out quickly. West of the present inland margins of commercial cropping, the rainfall variability increases rapidly. This problem will be one of the most serious to contend with if attempts are made to establish commercial-crop agriculture without irrigation inland of present limits.

In striking contrast to exotic crops and pastures, the indigenous plant communities appear well adapted to withstand the marked and extreme fluctuations in rainfall that occur. Xerophilous characteristics are pronounced, and as a consequence the plant communities are normally unaffected by adverse rainfall conditions in any one year. The native grassland communities of Western Queensland, however, are interesting exceptions. Conspicuous changes in the abundance of annual and ephemeral plants are common and often reflect the large-scale variations in rainfall which are characteristic of the grasslands. And in some districts a fluctuating dominance among the important perennial constituents has been observed.[2] In especially dry years for example, blue-grass (*Dicanthium sericeum*) dominant communities have been fundamentally altered by the incursion of the more drought-tolerant mitchell grasses (*Astrebla spp*). In particularly moist years, however, the reverse trend is evident and occasionally mitchell-grass communities have been temporarily transformed into blue-grass dominant associations.

Few semi-arid and arid lands of the world are so intensively utilized for pastoral purposes[3] as are those in Queensland. Success is achieved in spite of a low and particularly erratic rainfall, and remoteness from markets. Important factors which outweigh or obviate these disadvantages are:—

1. In the Darling Downs and in the south Burnett district, during the last 20 years, grain sorghum has largely replaced maize as the main summer-grain crop because of its greater success under conditions of irregular or insufficient rainfall and its ability to be mechanically harvested.
2. Other important factors influencing floristic and physiognomic changes in the grasslands are changes in salt concentration in the soils and grazing by livestock. For details see S. T. Blake, "The Interrelationship of The Plant Communities of Queensland," *Proceedings of the Royal Society of Queensland*, vol. 51, no. 4 (1939).
3. Primarily sheep rearing for wool or raising beef-cattle.

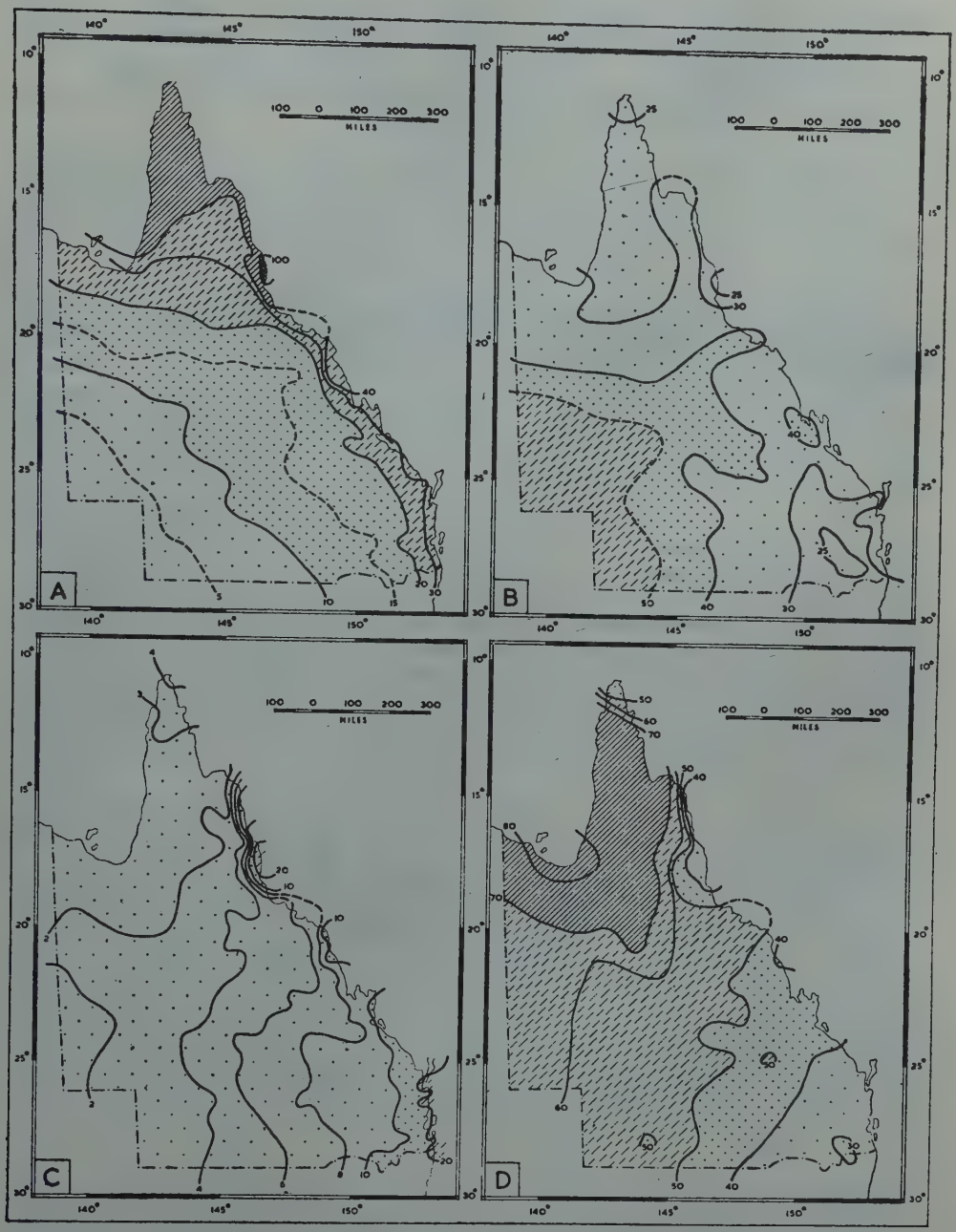


Fig. 4. Queensland.

A. 'Wet-season' rainfall (November-April inclusive: in inches).

B. Relative variability of 'wet-season' rainfall (mean deviation expressed as a percentage of average 'wet-season' rainfall).

C. 'Dry-season' rainfall (May-October inclusive: in inches).

D. Relative variability of 'dry-season' rainfall (mean deviation expressed as percentage of average 'dry-season' rainfall).

(i) the widespread occurrence of artesian water-resources which, although usually unsuitable for irrigation purposes, provide a reliable supply for watering livestock.

(ii) the natural preservation of surplus summer growth, *in situ*, during the virtually rainless winter half-year.[1]

(iii) the presence over extensive areas of numerous edible shrubs,[2] which can be fed to livestock during times of prolonged droubt, e.g., mulga (*Acacia aneura*), myall (*A. pendula*), boree (*A. cana*), wilga (*Geijera parviflora*).[3]

(iv) the availability of speedy transport by road or rail to coastal meat-works or agistment areas in times of sustained drought.

A century's experience in these climatically unfavoured lands, has resulted in graziers normally adopting the wise practice of maintaining in all years a stock density equal to the carrying capacity in poor years.

The Richmond-Winton-Kynuna district, which records the lowest average lambing percentages in the state,[4] is an area with outstandingly variable rainfall. The level of nutrition fluctuates erratically and this has proved inimical to the fertility of rams and to the health of ewes in lamb.[5]

The channel country of south-western Queensland is of special interest. The area is used primarily for the fattening of beef-cattle. Pastoral occupation has proved successful, in spite of the fact that this region receives the lowest and most variable rainfall in the state. The diversified and economically valuable vegetation of the channel country—galeria forests, swamps, and luxuriant herb-meadows owe their existence not to local rainfall but to moisture retained in the soil during and after the subsidence of flood-waters which rise in higher-rainfall districts to the north and east. The extremely slight gradients of the land in most of the channel country result in the widespread dispersal of flood-waters; in the case of the Cooper and Diamantina Rivers, the lateral spread of waters is in places 30 to 50 miles.

The challenge of climate to European settlement in Queensland has long engaged interest. A century's occupance has proved white settlers capable of satisfactory physiological and mental adjustment to the tropical and subtropical climates experienced. However, climate poses major difficulties to land utilization in many areas. The pronounced variability of annual and seasonal rainfall is an important limiting factor. Widespread and severe drought conditions during 1957 have again focussed attention on this recurring problem. The need for extended irrigation facilities, for enlarged water storage, for increased and improved fodder production and conservation, and for revision of stocking capacities has been keenly felt even in the so-called 'humid' coastal districts of central and southern Queensland. Planning to meet these needs, and thus achieve greater stability in agricultural production, and to allow for an extension of the limits of close settlement will require detailed attention to regional differences in rainfall variability.

1. Light showers in winter have an immediate destructive effect upon the dry fodder—it blackens, disintegrates and is quite useless for stock. However, if substantial winter rains are received an adequate fresh growth of grasses and other herbs is induced.
2. More than 150 edible species have so far been listed.
3. Stock distinguish between two strains of wilga—one is relished, one is avoided, and there are no apparent morphological or floristic distinctions.
4. About 50-55 per cent.
5. The long 'winter' dry season, and the prevalence of daily maximum temperatures above 95°F in summer are important factors also.

# THE GOLD-MINING ERA IN KENYA COLONY

By HUGH FEARN

An isolated chapter in the economic development of Kenya Colony is that concerned with the discovery of gold, its commercial development and its sudden decline. Geographically limited to the Nyanza Province the story concerns the impact of limited industrialization upon an indigenous community and three major questions appear pertinent to this phase of Kenya's economy. Firstly, the discovery of gold in the early nineteen-thirties when European farming was at a low ebb due to the world depression: how far was this beneficial to impoverished settlers and what was the contribution of gold to the Kenya economy during these 'lean years' ? Second, what were the reasons for the sudden eclipse of the industry immediately following upon the period of rapid-growth of gold-mining in Nyanza? And do these reasons shed any light upon the problems of mining and industrialization in under-developed territories? Thirdly, and most important, what were the immediate and subsequent effects of the gold-mining impact up the indigenous peoples of Nyanza?

Although it was known a early as 1904 that there was gold in the neighbourhood of Lake Victoria Nyanza[1] it was not until 1931, when gold was discovered in the Kakamega region that the gold-rush really started.[2] Why was it that with such knowledge of the existence of gold prospecting did not begin until 1931, with the exception of the spasmodic development of mining in the Lolgorien goldfields[3] between 1926 and 1930?[4] The question is a difficult one to answer, but it is probable that there were at least four contributory causes. Early European interest in Kenya had been directed towards the suitability of apparently unoccupied tracts of land in 'the Highlands' for European farming, and this had remained the prime interest of European settlement. This very act of European settlement had raised the Land Question, and this was far from being solved in 1931. Thus it would have been unwise to have entered a region of comparatively dense African occupation to have begun mining without some certainty of the results of the enterprise. Indeed, as will be related subsequently, there was a considerable outcry when prospectors and miners were allowed into the Kakamega area. The belated prospecting for gold in Nyanza may also be explained by the costliness of mining in the Lolgorien area where until 1930 it was commonly said that, "More gold went into the ground than has come out of it."[5] There had in fact been no substantial discoveries of gold[6] and further prospecting had been hindered by lack of capital. Furthermore the Lolgorien area was, comparatively speaking, inaccessible and most of it was situated in tsetse-fly country. These reasons may

1. *Mining in Kenya Colony: Mining Pamphlet No. 1* (Nairobi, 1936), p. 1.
2. Native Affairs Department, Kenya: *Annual Report, 1931,* p. 8.; Lands and Settlement Commissioner, Kenya: *Annual Report, 1931,* p. 74. The credit of the discovery belonged to L. A. Johnson of the Eldoret Mining Syndicate.
3. As will be seen from the map on page 00, the Lolgorien goldfields were in the Masai Extra-Provincial District just to the south of the Nyanza Province.
4. *Mining Pamphlet No. 1,* p. 8.
5. Lands and Settlement Commissioner: *Annual Report, 1930,* p. 73.
6. The output of the four companies which operated in the Lolgorien area during the years 1926 to 1931 amounted to 2,565 ounces. Lands and Settlement Commission: *Annual Report, 1932,* p. 73.

Fig. 1. Gold-fields of Kenya Colony. Based on a map compiled by V. Ford and incorporating information from the Kitson Report (Nairobi, 1933).

explain the absence of prospecting in the Nyanza province until the discovery of gold near Kakamega in 1931.

Once a lucky strike had been made there was every incentive for the European in Kenya to begin mining at this particular moment in time. The world depression had knocked the bottom out of prices for primary products and the settlers were handicapped in meeting the charges on their land and the costs (though small) of their labour. As gold might possibly be obtained the easy way, with a saucepan and a sieve, there was every attraction for at any rate establishing a claim and doing some alluvial, if not lode mining. The capital requirements in this early stage were low, there seemed little more to lose and the prospect of much to gain.

The rapid development of prospecting in the Kakamega area which followed upon the discovery of gold in that region,[1] and more especially the application of Tanganyika Concessions Ltd. for an *Exclusive Prospecting Licence* (under the *Mining Ordinance, 1931*) over an area of 5,900 square miles in the Nyanza province, forced the Kenya government into obtaining expert advice and making policy decisions. Faced with such rapid developments the government had to formulate policy with regard to alienation of land for mining and to determine how the mineral rights would be controlled. The Carter Land Commission, then in session, was entrusted with the former problem and recommended that 1,500 acres of forest land in the Elgon Forest Reserve be added to the North Kavirondo Reserve for possible compensatory claims.[2] The bitter controversy which arose over the proposal to alienate further land from the North Kavirondo Reserve is discussed in relation to the immediate effects of gold-mining upon the indigenous peoples of the area. The technical advice with regard to the programme for development of the mineral workings was entrusted to the geologist, Sir Albert Kitson, who opposed the granting of an exclusive licence to one company and divided the gold-fields of Nyanza (exclusive of the Kakamega gold-field where prospecting was already proceeding apace) into five areas according to their differing geological conditions.[3] These varied geological conditions imposed upon the gold-mining industry appropriate methods of obtaining the gold from the earth. Kitson aimed at providing the government with some basis for deciding which areas should be opened to general prospecting and those areas where more heavily capitalized and industrialized mining would be appropriate. The Map on page 00 shows these areas (1 to 5) and also the previously existing gold-fields of Lolgorien and Kakamega.

The development of mining activity in the Nyanza gold-fields followed the pattern to be expected as successive *Areas* were opened either to exclusive or general prospecting. The first few years were characterized by the establishment

1. This can be seen from the increase in the Number of Registered Claims, as follows:—

| *Year* | *Claims Registered as at 31st December* |
|---|---|
| 1930 | 309 |
| 1931 | 1074 |
| 1932 | 7358 |
| 1933 | 18529 |
| 1934 | 23158 |

2. *Report of the Kenya Land Commission (Sept. 1933). Cmd. 4556 of 1934*, p. 301.

3. *Report by Sir Albert Kitson on the Application by Messrs. the Tanganyika Concessions Limited for an Exclusive Prospecting Licence under the Mining Ordinance, 1931, in respect of an area of 5,900 square miles approximately in the North, South and Central Kavirondo Districts, Kenya Colony* (Nairobi), 1933).

of numerous claims, the majority of them of individual prospectors. Most of those who made money did so by working the surface and selling to the large mining companies. Perhaps half a dozen made £50,000 or more.[1] As already mentioned there was a considerable increase in the number of claims registered each year subsequent to the discovery of gold in the Kakamega region. There was later a decline as claims were abandoned. This gradual decline of the individual prospector began to make itself felt towards the end of 1934,[2] with the emergence of the larger mining companies and syndicates, particularly in the Kakamega area.[3] Most of these larger undertakings first obtained an Exclusive Prospecting Licence, and having established worthwhile claims they then applied for a mining lease. The first lease to be granted was one of 113 acres on the Kakamega gold-field to the Kimingini Goldmining Company in August 1935[4] Rosterman Goldmines Limited, a company floated in 1935 and destined to become the largest producer of gold in Kenya, also obtained a mining lease.

The flotation of Rosterman's and other companies in 1935 was the more remarkable because of the havoc wrought upon mining finance by the Italo-Abyssinian War. Shortage of funds reacted seriously on the gold-fields and the development programmes of several companies and syndicates were delayed or held up by lack of foreign capital.[5] Those companies which were launched in association with established mining groups elsewhere in the world fared the best[6] but they did not altogether escape the fluctuations of the share market.[7] None the less with little additional outside capital after 1936[8] the gold-mining industry in Kenya progressed. With the outbreak of hostilities in Europe in 1939 it seemed more than ever desirable for the infant industry to try and increase the gold output of the area and thus assist the economy of the colony. But adverse conditions triumphed and output declined after 1941. The post-war experience of the industry in Nyanza has been of a continuous decrease in the quantity of gold output.

The main trend of the rise and fall of gold-mining in Kenya (and that mainly indicative of the Nyanza gold industry) is indicated by the figures of unrefined and refined gold production as shown in Table 1 and Table 2 respectively. The absence of annual figures of refined gold output for the decade 1926-1935 hides the gradual development up to 1930. Some indication, however, of the accelerated output after 1931 is indicated by the annual unrefined gold production figures as shown in Table 1. From this Table it will be seen that within a year of the discovery of gold in the Kakamega area the output of the North Kavirondo District exceeded that of all other areas. Further, the gap in favour of the North Kavirondo district increased year by year as the output of the Kakamega gold-field increased. Further the decline was the more marked in this area, so that, in

1. I am indebted to Mr. A. Valentine of Kakamega for this information.
2. Assistant Warden of Mines, Kakamega: *Annual Report, 1935.*
3. Assistant Warden of Mines: *Annual Report, 1934.*
4. Assistant Warden of Mines: *Annual Report, 1935.*
5. Mining and Geological Department: *Annual Report,* 1935, p. 2.
6. "There is a remarkable contrast between the old established mining companies and the large new companies formed to exploit these gold-fields. The latter have spent money like water, but will not offer salaries high enough to secure good technicians, with disastrous consequences." Assistant Warden of Mines, *Annual Report, 1934.*
7. The drastic fall in the value of shares of certain of these companies as between 1st January and 31st December 1936 is quoted in the Provincial Commissioner, Nyanza Province: *Annual Report, 1936,* p. 122.
8. Mining and Geological Department: *Annual Report, 1938,* p. 3.

the main, the gold-mining chapter of Kenya's economic history might well be entitled, "The Rise and Fall of Kakamega." Table 1 also indicates that the bulk of production was from reef or lode-mining, and that gradually (as the individual prospector left the area) the amount of gold produced by alluvial mining diminished as a percentage of the total gold production. In a comparatively few instances mining at depth was developed.[1]

TABLE 1: UNREFINED GOLD OUTPUT, 1926-1939

| YEAR | North Kavirondo | | Central Kavirondo | | South Kavirondo | | Masai Province | | TOTAL |
|---|---|---|---|---|---|---|---|---|---|
| | Lode oz. | Alluvial oz. | Lode oz. | Alluvial oz. | Lode oz. | Alluvial oz. | Lode oz. | Alluvial oz. | oz. |
| 1926 | — | — | — | — | 667 | — | — | — | 667 |
| 1927 | — | — | — | — | 661 | — | — | — | 661 |
| 1928 | — | — | — | — | 707 | — | — | — | 707 |
| 1929 | — | — | — | — | 845 | — | — | — | 845 |
| 1930 | — | — | — | — | 1,739 | — | — | — | 1,739 |
| 1931 | — | 404 | — | — | 2,765 | — | — | — | 3,169 |
| 1932 | — | 6,015 | — | — | 4,779 | — | — | — | 10,793 |
| 1933 | 4,427 | 3,655 | — | — | 6,050 | 5 | — | — | 14,147 |
| 1934 | 6,765 | 3,284 | — | — | 5,890 | — | — | — | 15,939 |
| 1935 | 14,293 | 3,475 | 5,553 | 598 | 4,651 | — | 608 | — | 29,178 |
| 1936 | 23,785 | 3,864 | 11,853 | 494 | 7,462 | — | 1,177 | — | 48,635 |
| 1937 | 35,713 | 3,814 | 16,438 | 127 | 10,845 | — | 1,740 | — | 68,677 |
| 1938 | 41,254 | 3,705 | 28,091 | 35 | 13,014 | — | 2,038 | — | 88,137 |
| 1939 | AREA FIGURES NOT AVAILABLE | | | | | | | | 104,076 |

The sudden decline in output of the Kenya gold-fields contrasts very sharply with the accelerated development of the mid-thirties. What were the reasons for this decline and does the Nyanza experience shed any light upon the problems facing mining and other industrialization in colonial territories? The decline was due to a combination of several factors which need examining. The principal causes of decline were: the exhaustion of mineral deposits, the difficulties of mining finance, the problems of labour-management relations, the peculiar problems of African labour supply and its instability, and increasing costs.

There is earlier evidence than the post-war years of the exhaustion of mineral resources in some instances. The decline in the number of individual prospectors and of claims registered from 1935 onwards is an indication that the more accessible gold had been worked out. Particularly is this evident in the decline of alluvial claims. When *Area Five* was opened for general prospecting in June 1933 the anticipated gold-rush resolved itself into the quiet entry of some forty prospectors.[2] In November 1935 when *Area One* was opened to general prospecting only twelve prospectors showed any interest in the area, and most of these only stayed for a few days. The prospectors had been discouraged by a report on the area just published by the government geologist.[3] There is early evidence

1. Two mines had reached depths of between 600 and 700 ft. by 1937. Mining and Geological Department: *Annual Report, 1937*, p. 7. The Commissioner (Mines and Geological Department) (Mr. Harverson) informs me that later one of these mines went down to a depth of well over 2,000 ft.
2. Mining and Geological Department: *Annual Report, 1933*, p. 4.
3. Warden of Mines, Kisumu: *Annual Report, 1936.*

therefore, that the area was not so rich in deposits as was at first thought and that increased prospecting was only evident at times of rich strikes, such as the Kakamega discovery in 1931 and that in Sakwa country in September 1934. One of the reasons for the decline of the industry in the post-war years was the loss of interest by large mining concerns because no ore body was found large enough, and with a long enough mining life, to attract capital.

TABLE 2: REFINED GOLD PRODUCTION 1926-1953 WITH TOTAL WAGES BILL IN RELATION THERETO, 1936-1953

| YEAR | REFINED GOLD PRODUCTION | | TOTAL WAGES PAID |
|---|---|---|---|
| | OUNCES | VALUE £ | £ |
| 1926/35 | 66,897 | 386,135 | — |
| 1936 | 41,753 | 269,947 | 234,181 |
| 1937 | 54,073 | 379,626 | 182,839 |
| 1938 | 69,435 | 499,601 | 160,949 |
| 1939 | 77,445 | 607,753* | 182,224 |
| 1940 | 77,243 | 648,783 | INFORMATION NOT AVAILABLE |
| 1941 | 72,148 | 606,042 | 176,031 |
| 1942 | 56,771 | 476,879 | 156,858 |
| 1943 | 45,118 | 378,989 | 113,700 |
| 1944 | 42,259 | 354,976 | 112,352 |
| 1945 | 38,517 | 313,259 | 104,414 |
| 1946 | 29,892 | 257,942 | 109,946 |
| 1947 | 21,959 | 189,397 | 116,772 |
| 1948 | 23,429 | 202,076 | 126,431 |
| 1949 | 20,071 | 201,237 | 141,300 |
| 1950 | 22,945 | 284,806** | 165,393 |
| 1951 | 19,765 | 245,458 | 167,109 |
| 1952 | 10,209 | 131,881 | 212,234 |
| 1953 | 9,603 | 122,801 | 225,519 |

Note: The yearly value of gold is the total gross amounts received by the producer during the year.

* In October 1939 the price of fine gold was fixed on the London market at Sh. 168 per ounce as against the former price of Sh. 148.

** The effect of the devaluation of the £ sterling was to increase the price of gold per fine ounce from Sh. 172/50 to Sh. 248/50.

Source: Mines Department Annual Reports, 1931-1953.

Reference has already been made to the difficulties of mining finance in the mid-thirties when the development programmes of many companies and syndicates were held-up by the lack of foreign capital. In the early thirties individual prospectors had also been handicapped by lack of capital.[1] The 'lean years' of the early 'thirties meant that local capital was limited. Information, however, on the avenue of investment is not easily obtainable. The returns to the Registrar of Companies at Nairobi do not reveal very much about the source of investment, other than in the case of locally registered companies. Quite frequently the

1. Warden of Mines: *Annual Report 1936.*

capital in these local companies was subscribed in Kenya, in London and in Johannesburg.[1] The larger mining concerns were, of course, linked up with other mining groups elsewhere in the world.

TABLE 3: EMPLOYMENT IN THE MINING INDUSTRY (LODE AND ALLUVIAL) AND TOTAL WAGES PAID, 1934-1953

| YEAR | NUMBERS EMPLOYED | | | | TOTAL WAGES PAID | | | |
|---|---|---|---|---|---|---|---|---|
| | EUROPEANS | ASIANS | AFRICANS | TOTAL | EUROPEANS £ | ASIANS £ | AFRICANS £ | TOTAL £ |
| 1934 | 489 | — | | | 92,399 | — | 57,714 | 150,113 |
| 1935 | 632 | — | 14,943 | 15,575 | 154,836 | — | 92,713 | 247,549 |
| 1936 | 426 | 185 | 11,109 | 11,720 | 141,096 | 23,288 | 69,797 | 234,181 |
| 1937 | 284 | 151 | 8,809 | 9,244 | 107,239 | 15,147 | 60,453 | 182,839 |
| 1938 | 248 | 138 | 8,943 | 9,329 | 84,894 | 18,541 | 57,514 | 160,949 |
| 1939 | 265 | 141 | 10,777 | 11,183 | 89,221 | 19,594 | 73,409 | 182,224 |
| 1940 | | | | No figures available | | | | |
| 1941 | 168 | 173 | 8,679 | 9,020 | 80,280 | 28,082 | 67,669 | 176,031 |
| 1942 | 138 | 169 | 7,133 | 7,440 | 71,783 | 27,794 | 57,281 | 156,858 |
| 1943 | 105 | 126 | 5,202 | 5,433 | 52,096 | 19,833 | 41,771 | 113,700 |
| 1944 | 116 | 99 | 4,140 | 4,355 | 54,496 | 19,331 | 38,525 | 112,352 |
| 1945 | 97 | 99 | 3,650 | 3,846 | 47,366 | 21,017 | 36,031 | 104,414 |
| 1946 | 96 | 106 | 3,431 | 3,633 | 49,919 | 23,164 | 36,863 | 109,946 |
| 1947 | 84 | 95 | 3,625 | 3,804 | 48,902 | 25,840 | 42,030 | 116,772 |
| 1948 | 76 | 93 | 3,180 | 3,349 | 52,408 | 28,206 | 45,817 | 126,431 |
| 1949 | 88 | 78 | 3,480 | 3,646 | 59,576 | 29,670 | 52,054 | 141,300 |
| 1950 | 102 | 79 | 3,999 | 4,180 | 77,020 | 26,684 | 61,689 | 165,393 |
| 1951 | 131 | 50 | 3,377 | 3,558 | 94,717 | 14,704 | 57,688 | 167,109 |
| 1952 | 146 | 61 | 2,860 | 3,067 | 111,652 | 24,753 | 75,829 | 212,234 |
| 1953 | 121 | 62 | 2,896 | 3,079 | 118,553 | 27,046 | 79,920 | 225,519 |

Source: Mines Department Annual Reports, 1934-1953. Compiled from half-yearly returns to the Department.

Pertinent to the problems which have accounted for the sudden eclipse of gold-mining in Nyanza is the question of personnel, both management and of labour. Here was a situation of a comparatively small European personnel, not all having the skill necessary nor the knowledge desirable for the successful pursuance of mining, having to teach, direct and discipline a locally recruited labour force. Many companies were not prepared to offer salaries high enough to secure good technicians[2] and probably tried to recruit locally so far as possible. And yet technicians of the highest order were the more necessary in view of resort to improvisation to overcome shortages of spares and tools. The European personnel was considerably reduced during the war-period[3] by the calling-up of mining staff. The difficulties of management and supervision were further enhanced

1. Kenya Consolidated Goldfields Ltd. was registered as a public company in Kenya in 1933. Of the share capital issued in 1934, £12,000 was subscribed in Kenya, £25,000 in London and £23,000 in Johannesburg.
2. Assistant Warden of Mines, Kakamega. *Annual Report, 1934.*
3. See Table 3.

by the inexperience of the mainly African labour-force. Documentary evidence of the composition and behaviour of this African labour-force is limited, although annual figures are available of the size of the labour-force and of its earnings for the period 1934 to 1953.[1] The only official evidence of how the African was employed and of the tribal composition of the labour-force in mining and its associated industries is the *Special (Mining Areas) Labour Return, October 1935.*

In October 1935 the African labour-force employed in the gold-mining industry totalled 13,450 according to the returns submitted by 150 mining undertakings. An additional 665 Africans were engaged by contractors or employed in domestic and personal service which represented associated employment as a result of mining demands.[2] The tribal make-up of this labour-force and its geographical distribution throughout the gold-fields (including Lolgorien) is shown in Table 4. These figures suggest that the labour-force in each area was largely composed of locally recruited Africans. The Luyia of North Nyanza supplied the greater number of workers in the Kakamega area. The mines in the Kisumu area were principally served by the tribe of the neighbourhood, the Luo. The adjacent gold-field areas of Kisii and Lolgorien had a mainly Kisii labour-force. The classification of the African labour-force according to the major tribal groupings does not permit an accurate analysis of the localization of the labour-force. Distributed as the Luyia were throughout the whole of the North Nyanza district it would have been preferable for the return to have specified the sub-tribe of the employees. It is known, however, that the Kakamega employers had a preference for Maragoli males for employment underground;[3] and that the Wasuka who occupied an area of about 15% of the Kakamega gold-field, failed to take advantage of the new employment opportunities offered by the advent of the gold-mines.[4] This sub-tribe alone proved unsuitable for employment in the mines; otherwise local labour generally proved quite suitable and was widely used.

The greatest employment-category in the gold-mining industry was that of surface labours with another large group of underground labourers. These were non-skilled jobs. There were, however some Africans employed in skilled jobs but mainly of a routine nature such as mill and power-house shift-work, the repairing of broken electric lines, etc. Table 5 indicates the number of Africans in specified skilled and unskilled work in October 1935 and shows the range of wages from that of the surface-labourers at the lower end of the scale to that of the best-paid skilled workers, the masons, at the other end. Unfortunately we have no similar analysis of the occupational pursuits of Europeans and Asians engaged in the industry, nor of their earnings (other than total annual wages) so that a comparison is not possible. The occupational classification used in this labour return includes within the skilled groupings those Africans employed as clerks, office assistants, lorry and motor-drivers. These can hardly be described as being within skilled-mining operations, though their essential contribution to the running of the industry is not to be denied. Blacksmiths, carpenters and masons admittedly have a more direct link with the problems of mining, but if there were any skilled operators of mining equipment these would appear to

1. See Table 3.
2. Of the 14,115 Africans employed in the mining and associated industries in October 1935, 70·1% were employed by 31 mining companies, 3·6% by syndicates, 2·8% by partnerships, 5·1% by individual owners, 13·7% by prospecting and alluvial employers, 3·3% by 6 contractors and 1·4% in domestic and personal employment.
3. Native Affairs Department: *Annual Report, 1933*, p. 124.
4. Native Affairs Department: *Annual Report, 1933*, p. 4.

be under the miscellaneous category "Other skilled workers." The exception from the routine work at Rosterman's mine was an African machinist, working on lathes, shaping and planing machines, who could, from a machine-drawing make, say, a crown wheel or a spur wheel to a 1/1000 of an inch.[1]

TABLE 4: MINING (AFRICAN) LABOUR FORCE, OCTOBER 1935: TRIBAL COMPOSITION AND GEOGRAPHICAL DISTRIBUTION

| TRIBE | GEOGRAPHICAL DISTRIBUTION | | | | TOTAL |
|---|---|---|---|---|---|
| | KAKAMEGA | KISUMU | KISII | LOLGORIEN | |
| LUO | 1,815 | 3,070 | 161 | 35 | 5,081 |
| LUYIA | 4,515 | 569 | 129 | 3 | 5,216 |
| KISII | 225 | 134 | 1,949 | 806 | 3,114 |
| OTHER KENYA TRIBES | 114 | 14 | 31 | 37 | 196 |
| UGANDA TRIBES | 37 | 4 | 5 | 1 | 47 |
| TANGANYIKA TRIBES | 73 | 11 | 182 | 152 | 418 |
| MISCELLANEOUS | 35 | 1 | 7 | | 43 |
| TOTAL | 6,814 | 3,803 | 2,464 | 1,034 | 14,115 |

Note: This Table illustrates the localized recruitment of the African labour-force. Of the three Nyanza districts—Kakamega (North Nyanza), Kisumu (Central Nyanza) and Kisii (South Nyanza)—the local tribesmen provided 95·3% of the total labour-force in October, 1935. In the Lolgorien gold-field (in the Masai Extra-Provincial District) adjacent to South Nyanza, the Kisii provided 77·95% of the labour-force. The largest non-local section of the labour-force came from Tanganyika and found employment principally in Kisii and Lolgorian. Of the "Other Kenya Tribes," 114 worked in the Kakamega area, and included 69 Nandi and 38 Kikuyu.

There was little overall difference between the total numbers of Luo and Luyia employed in the mines in 1935. It will be seen, however, that with the exception of clerical employment and "other skilled labour", that the Luo have a slight advantage in the skilled occupations. From the time of the railway-building era the Luo have been much more evident in the employment sphere, and it may be due to individual experience acquired in railway construction and other works that this group emerged. The indigenous peoples of North Nyanza were not, however, without some experience in iron-working.[2] The available evidence does not indicate how the African was employed, although the lack of skilled labour was claimed as a handicap to the development of the industry. It is true that education mostly stressed literacy, health, religious and political responsibility, and that technical skills were taught but in a few places.[3] This lack of skilled training on the part of the African combined with a limited European supervision certainly added to the problems of gold-mining, especially when mining had to be undertaken at a greater depth.

The second world war added to the difficulties of the mining industry in Nyanza. Shortages of tools and equipment, the delayed delivery of spare parts and the withdrawal of European and other personnel to serve with the forces

1. I am indebted to Mr. Valentine of Kakamega for this information.
2. "The people of Samia, Nyala and Ketosh are great ironworkers, smelting the iron from the native ore with charcoal, and forging hoes, spears, hatchets, knives etc., with great skill"—C. W. Hobley, "Kavirondo," *The Geographical Journal.* vol. 12 (1898), p. 369.
3. E. Hoyt, "Economic sense and the East African impressions of a visiting American economist," *Africa,* vol. 22 (1952), p. 165.

was accompanied by a trend of increased costs. It is considered that a contributory factor to the post-war decline of the industry was the incidence of increasing costs.[1] Even the increased price per ounce of fine gold from Sh.172/50 to Sh.248/25, brought about by the devaluation of the pound sterling, was insufficient to bring about any noticeable change in the gold-mining activity of Nyanza. An indication of the increased costs of production can be seen from the increased

TABLE 5: OCCUPATIONAL COMPOSITION OF THE AFRICAN MINING LABOUR-FORCE IN OCTOBER, 1935

| OCCUPATION | AVERAGE MONTHLY WAGE SHS. CTS* | TOTAL SO EMPLOYED | WHICH INCLUDES | | |
|---|---|---|---|---|---|
| | | | LUO | LUYIA | KISII |
| CLERKS | 30.77 | 45 | 11 | 15 | 10 |
| OFFICE ASSISTANTS | 25.00 | 3 | | 3 | |
| LORRY AND MOTOR DRIVERS | 32.11 | 36 | 9 | 8 | 8 |
| BLACKSMITHS | 26.24 | 29 | 10 | 6 | 7 |
| CARPENTERS | 37.74 | 51 | 18 | 18 | 3 |
| MASONS | 42.80 | 15 | 12 | | 1 |
| OTHER SKILLED LABOUR | 15.44 | 141 | 40 | 66 | 22 |
| POLICE AND WATCHMEN | 17.98 | 106 | 28 | 51 | 8 |
| HEADMEN | 16.58 | 197 | 53 | 106 | 27 |
| SURFACE LABOURERS | 8.16 | 7369 | 2836 | 3096 | 1146 |
| UNDERGROUND LABOURERS | 11.12 | 4658 | 1832 | 1330 | 1312 |
| LABOURERS (UNSPECIFIED) | 8.55 | 607 | 55 | 203 | 284 |
| HOSPITAL ATTENDANTS | 25.65 | 23 | 6 | 6 | 6 |
| COOKS (COMPOUND) | 8.59 | 27 | 3 | 15 | 9 |
| COOKS (DOMESTIC) | 24.74 | 79 | 18 | 29 | 15 |
| OTHER INDOOR DOMESTIC SERVANTS | 14.98 | 185 | 34 | 77 | 53 |
| OUTDOOR DOMESTIC SERVANTS | 13.38 | 32 | 5 | 19 | 8 |
| FUEL CUTTERS | 10.16 | 371 | 93 | 151 | 109 |
| SWEEPERS | 15.80 | 35 | 2 | 8 | 9 |

* In East African currency, Sh. 20 is related to £1 sterling and 100 cents is the equivalent of one East African shilling (Sh.).

wages bill of 1953 over the 1939 expenditure, in relation to the size of the employment-force. Costs of materials rose sharply, and the Nyanza mines were at a disadvantage all along to the mines in South Africa, for the price of gelignite was 2½ times more in Kenya, and other things such as drill steel, steel balls, carbide, all in about the same proportion. There was also the inevitable increase in cost of production which accompanied mining at a greater depth.

The industrial experience of gold-mining in Nyanza underlines certain problems common to "under-developed" economies where there are the beginnings of industrialization. Besides the social consequences of the impact of industry upon the indigenous peoples there are important economic considerations. Where the state of a country's economy is such that there is insufficient local capital

1. "The conditions governing the gold-mining industry have altered very little during the year. Any alteration has been for the worse, since operating costs continued to rise and the price of gold remained constant." Lands, Mines and Surveys, *Annual Report, 1948*, p. 2.

available,[1] then the conditions of the world investment market must be such as to attract capital to the country, which presupposes that the prospects of reward must be sufficiently attractive to induce investment. There was insufficient local capital in the case of gold-mining in Nyanza in the early 'thirties, nor was this an ideal time for attracting overseas investment. Later experience of the industry proved also that the conditions of reward were not sufficiently high to maintain capital interest in the Nyanza gold-fields. In a country where the costs of mechanization are high in relation to labour costs, every attention must be paid to the effective utilization of the available labour-force. This labour-force will only remain a "cheap expenditure" if adequately supervised and if the minimum amount of skilled operation is required of it in relation to its experience of industry. This means the engagement of suitably qualified managerial and technical staff. This does not always appear to have been the practice in the case of the Kenya gold-mining industry. The conditions for the attraction of adequate capital and the expenses of mechanization and engagement of suitably qualified staff require that "the efforts will be rewarding." In the case of gold-mining this necessitates a survey of the areas for development. *Area One,* which Kitson considered an area suitable for large-scale mining, proved not to be the case. It would appear that political and economic distress might have been avoided had survey work been undertaken on a more detailed and extensive scale before the gold-fields were opened to both general and exclusive prospecting. Admittedly insufficient revenue prevented the Kenya government from undertaking such surveys until money did in fact accrue to the department from mining fees, assay fees and royalties.

What then were the advantages of the gold-mining era to the economy of Kenya Colony? The indigenous people of Kenya (including those of the gold-field areas), together with European settlers and Asian immigrants were in 1931 experiencing the effects of the world depression. The Asian trader, who had been steadily advancing in trade in the colony, suddenly felt the effects of this unexpected world economic blizzard.[2] Those few Asians who had settled on the land in the Kibos area of Nyanza province, below the Nandi escarpment, were hard hit by the position of the sugar-cane industry in 1931 and the loss of their maize crop by a locust invasion.[3] The African farmer of Nyanza also suffered loss of food crops from the locust invasion and the opportunities for the African to earn wages was lessened by the condition of European farming. The sudden rush of prospectors, who were in the main settlers, can be explained in part by the lamentable position of agriculture at that time, though the natural impulse to get rich quickly cannot be ignored.

The benefits which accrued to the Kenya economy by the advent of gold-mining were largely internal benefits. The gold bullion export contribution to the total domestic export was but a small proportion of the whole. The internal benefits were those of increased revenue, improved means of communications, labour opportunity and other economic advantages for the indigenous peoples, and the hopes of the impoverished settler of alleviating his unfortunate position. These high hopes were sometimes more imaginary than real. Not all the prospectors

1. Ragnar Nurske, *Problems of Capital Formation in Underdeveloped Countries* (Oxford, 1953), p. 4. "The Vicious Circle of Poverty."
2. Provincial Commissioner, Nyanza Province: *Annual Report, 1931.*
3. District Commissioner, Kisumu-Londiani District: *Annual Report, 1951.*

who suddenly descended upon the Kakamega region[1] obtained tangible results for their labour and costs. With insufficient capital, and lack of skill, many prospectors failed in their endeavours and the abandonment of claims soon became a recurrent feature of the industry: "It is sad to record a diminution in the Total European population of the province from 2,777 to 1,740 during the year, but this was only to be expected and marks the departure of a number of alluvial workers, small miners and prospectors."[2] Although the entry of the prospector had caused great concern there is no doubt that during the mining era certain benefits accrued to the province. Kakamega and other areas were made more accessible by means of improved communications.[3] During its more active period the Nyanza gold-mining industry made a valuable revenue contribution to the government through mining fees, assay fees and royalties[4] which permitted the the Mines and Geological Department to carry out further surveys.

Perhaps the more permanent influence in Nyanza may well prove to be the results of the impact of the gold-mining industry upon the indigenous peoples of the province. These far-reaching social effects cannot be ignored, though they are difficult of assessment. The effects of the immediate impact are easier to determine than the subsequent effects. The immediate effects of the entry of prospectors and of the development of industrialized mining which need examination include the following items: African concern at the intrusion of the prospector and his fear for security of land, the adequacy of compensation for disturbance and the effectiveness of protection against abuse of the mining regulations; the economic opportunities both of labour employment and for the marketing of native-grown produce; the welfare provision of the mines offset by industrial disease (if any) accidents, and de-tribalization and disturbance of the traditional life and domestic economy.

It was inevitable that the natives would regard the intrusion of the European with misgiving, fearing for the security of their land. This invasion seemed to many of the Africans (and to people in England) a betrayal of government promises when the land which they occupied as a native reserve was now being re-claimed for gold prospecting. As so often happens the most vociferous element in African society proved to be those people who failed to take advantage of the new employment opportunities or to supply a new market with native produce. These were the Wasuka, a sub-tribe who occupied about 15% of the Kakamega gold-field, and they proved unsuitable employees and by and large they did not work their land. None the less they contended that they had been grievously dealt with.[5] But behind any outcry there is usually some legitimate cause of grievance and the Wasuka were not lone voices in the wilderness crying out against the intrusion of the prospector.

1. By October 1931 there were seventy-five prospectors at work in the Kakamega area—Native Affairs Department: *Annual Report, 1931,* p.8. By the end of the year over four hundred permits had been issued by the provincial headquarters—Provincial Commissioner, Nyanza Province: *Annual Report, 1931.*
2. Provincial Commissioner, Nyanza Province. *Annual Report, 1936.*
3. An all-weather road between Kakamega and Kisumu, an aerodrome at the latter township and other landing grounds were in operation as a result of the gold-mining industry.
4. On the average about £10,000 per year was collected in royalties, over £3,000 in mining fees and about £300 in assay fees. The revenue from royalties was somewhat uneven throughout the period due to changing regulations rather than fluctuating output. Until 1937 the rate of royalty was 5% on gold produced, then for three years royalties were suspended, in 1940 the 5% charge was re-imposed, but in 1941 a 15% charge on profits derived from mining was fixed as the royalty charge.
5. Native Affairs Department: *Annual Report, 1953,* p. 4.

The Kenya government could not await the recommendation of Kitson, on the technical development of the area, nor the results of the deliberations of the Carter Commission. There was an immediate urgency. Prospecting had already begun radiating outwards from Kakamega threatening the Kaimosi farms to the east and the populous locations of Maragoli and Bunyore in the south-west. The government immediately prohibited any further prospecting in these two locations.[1] There was a real danger in the situation besides the diplomatic argument of a betrayal of government promises which characterized much of the debate in England.

The Land Problem had long been a feature of controversy in Kenya and several attempts had been made by commissions and subsequent legislation to equate the position brought about by the existence of the undefined area of the "White Highland." The most recent ordinance prior to the gold-rush in Nyanza had provided, *inter alia,* "That no land should be even temporarily excluded from a reserve without consultation with both the Local Land Board and the Local Native Council, and without an area of equivalent value being added elsewhere."[2] Hardly had this Ordinance appeared upon the Statute Book than the entry of prospectors into North Nyanza proceeded apace. Where was the compensatory land to be found? Admittedly in an interim report dated 22nd March 1933 the Carter Commission recommended that 1,500 acres of forest land in the Elgon Forest Reserve be added to the North Nyanza reserve for possible compensatory claims.[3] But this recommendation was not made until two years had elapsed from the time of the entry of prospectors into the area, and in the meantime it had been agreed in principle by the Secretary of State that an amendment should be made to the *Native Lands Trust Ordinance, 1930* to permit cash compensation in lieu of land.[4]

Two questions arise from this principle. How far did the African accept this payment in lieu of land? And was the compensation offered to the African for disturbance and loss of land an adequate payment? It is clear from a petition addressed to the House of Commons by Luyia petitioners that payment in lieu was not acceptable.

> *"Compensation in Money instead of Land.*
>
> (3) Wherefore your humble petitioners are in great distress, for certain sections of the Native Lands Trust Ordinance, 1930, are being repealed as regards compensation due in land, by substituting money in lieu of land.
>
> Your petitioners pray that His Majesty's power of disallowance should be exercised over the Amendment Bill.
>
> (4) Wherefore your petitioners fully realise the importance of minerals, and these have to be dug out wherever they are found; but the amendment as it is proposed, purporting to change the form of compensation. . . is viewed with grave concern, and it is an appalling surprise that His Majesty's Government should go back on its word given to the natives of Kenya in which our only hope lies. Wherefore your petitioners pray that the pledge given should be invariably safeguarded."[5]

1. Mining and Geological Department, *Annual Report, 1933.*
2. L. P. Mair, *Native policies in Africa* (London, 1936), p. 66.
3. *Carter Commission Report,* p. 301.
4. Mair, *Native policies in Africa,* p. 86.
5. *Kenya Land Commission Evidence,* vol. 3 (1933), p. 2137.

The signatories to this petition were Africans associated with the Church Missionary Society and it is evident from the wording of the document that they have had the help and guidance of the missionaries. It is doubtful whether they did in fact agree that minerals "have to be dug out wherever they are found" or realize the importance of minerals. What is certain, however, is that it expresses their concern at the proposed amendment and that they regarded the government as "going back on its word" in allowing prospectors to enter the reserve.

It is much more difficult to assess the adequacy of the money compensation. What can, however, be said with certainty is that the compensation paid, whether as disturbance compensation or for loss of land, never acted as a corrective to the feeling of insecurity which this mining invasion brought about.[1] In the early prospecting days the more important compensatory payment was for "disturbance" and this was intended to offset losses incurred by the destruction of crops, huts and other buildings, during the search for gold.[2] Compensation for loss of land arose later when the mining companies and larger syndicates wanted Mining Leases. When Rosterman's obtained a twenty-one years' lease in 1935 the commuted rent was assessed at £755 and this sum was distributed in the following manner: seven-tenths to individual families as compensation for their loss of land, two-tenths to the locations effected and the remaining tenth of the revenue of the North Kavirondo Local Native Council. This Council spent part of the revenue thus obtained in the improvement of roads in the gold-field area. A similar distribution was made in 1936 of the £141 commuted rent for a mining-lease obtained by the Kenya Goldmining Syndicate.[3] The North Nyanza natives who petitioned parliament certainly did not favour this method of distribution. They favoured the principle that rents and compensations should be paid to those individuals who suffered loss of land or disturbance; and that the Local Native Council should have a percentage of royalties as its revenue from the gold-mining industry.

It cannot be argued that the commuted rent in both these instances represented a high assessment for a twenty-one years' deprivation of land. The significance of this commuted rent cannot be fully assessed for payment of the whole sum (in each case) was made to the Local Native Council. The Council then distributed the seven-tenths amongst the individual claimants. But how many there were for instance living on the 155 acres of the Rosterman acquired land it is not possible to say. Viewed in this light the compensation seems very small indeed. It is true to say, however, that perhaps only 10% of the acreage leased to Rosterman's was occupied by buildings and mining accessories, and that the African had access to the greater part of the area for grazing of his cattle and for obtaining wood and the like. Historically also, the land has reverted to the African earlier than the expiry time of the lease. It is doubtful, however, if the African peasant farmer realized the significance of commuted rent and that he had given away the right to use his land (or rather had the right taken away) for a single payment. Within the experience of the indigenous agrarian economy he was accustomed to the practice of allowing some other person a right to *use* his land, but knowing that he had the right to rescind that privilege when he himself wished to farm it. The initial impact of the mining industry created doubts

1. The intrusion is remembered some twenty years later. An American anthropologist beginning field work in North Nyanza informed me in 1955 that the Africans expressed a concern about a "European" taking up residence in the reserve; and reference was made to former experience with prospectors in the area.
2. Native Affairs Department: *Annual Report, 1931,* p. 95.
3. Native Affairs Department: *Annuel Report, 1936,* p. 152.

about security in land and the experience of compensatory payments was not such as to diminish those doubts.

This large item on the debit side of the account needs to be offset by the advantages which the mining industry claims to have brought to the community: opportunities to earn wages, to sell produce to the companies for their labourers requirements, welfare facilities made available to the people. There can be no doubt that the industry offered an opportunity to earn cash in the early 'thirties when there was little likelihood on the European farms, and also at a time when the ravages of locusts had destroyed the crops of the African farmers in Nyanza. But the emphasis on opportunity to earn cash, whether in wages or by the sale of produce to the mines, needs qualifying. It presupposes that the African wanted cash and that there existed a desire for goods or services which only cash could buy; or at any rate that the desire could be stimulated and was indeed encouraged by the growth of townships and trading centres with their Asian-owned dukas. Historically, these claimed benefits for the African mine-workers of the early 'thirties are disproved. The continued depression of the traders[1] suggests that the African did not become attracted by the display of wares. Admittedly some of the cash would be expended on the buying of cattle and of wives, and perhaps land; but his spending of money in this way further illustrates the limited consumer-range in Nyanza society.

Some Africans did, however, welcome the opportunity of wage-earning which the mines offered. These were the Africans, but a small proportion, who came from a distance and preferred to return to their homes for periods of leave and "with money to burn."[2] Usually they had some target for the earnings which the kinship obligations of African society make it difficult to attain unless work is underaken at some distance from the homestead. It is extremely difficult to accummulate savings (in cash or in kind) when relatives may descend upon you at any time and expect to receive assistance. The statistical information of the Labour Survey of October 1935 shows, however, that the major part of the labour-force was recruited locally; and therefore this opportunity to save without the obligations of kinship ties cannot be claimed as a widespread benefit of the gold-mining era.

Such changed standards of living that can justifiably be claimed as stemming from the industry were those made available by the companies in their labour-relations policy. The more highly organized mines tended to prefer their labour in camps where discipline could be maintained, under a European compound manager[3] and where there was less temptation to lay off work after a beer party the night before. In some instances the camp provision left much to be desired though, generally speaking, the Mines Department officers report satisfactory conditions. Some of the larger companies made serious attempts to look after the welfare of their employees. Kavirondo Gold Mines experimented with the issue of a hot meal three times a day for their miners, not without, of course, sound managerial motives. It was considered that better health and work would result, but native labour was not very responsive. In 1941 only about half the labour-force took advantage of the hot meals in lieu of dry rations.[4] Rostermans gave a hot drink to miners coming off-shift and some mines gave their employees an extra ration of *uji* (gruel) and sugar during working hours.[5]

1. Provincial Commissioner, Nyanza Province: *Annual Reports, 1931, 1932* and *1933.*
2. Native Affairs Department: *Annual Report, 1931,* p. 95.
3. Labour Department: *Annual Report, 1940,* p. 4.
4. Labour Department: *Annual Report, 1942,* p. 6.
5. Native Affairs Department: *Report 1939-1946,* p. 56; Labour Department: *Annual Report, 1942,* p. 6.

Welfare facilities included in some instances medical services. In October 1935 twenty-three Africans were employed as hospital attendants (Table 5), though what their duties were is not disclosed. At least one mine, Rosterman's, had its own hospital; and at one stage several mines subscribed to and supported the running of a joint hospital at Milimus. With mining at a depth being limited to a few companies, perhaps the accident rate was insufficient to necessitate any ambitious plans for the care of the injured. Indeed, considering the size of the labour-force—African, Asian and European—and its limited industrial experience, the accident rate was surprisingly low.[1] Welfare benefits accruing to the indigenous peoples employed in the mines needs to be offset by accident rates and the incidence of industrial disease. The accident rate, as already stated, was surprisingly low; and there is no evidence in the Annual Reports of the Kenya Medical Department of the existence of industrial disease among the African miners.[2]

The immediate effects of the gold-mining industry upon the indigenous peoples of Nyanza were a complexity of advantages and disadvantages. Allowing for the decline of the industry, more especially in the abandonment of claims in the early years with land reverting to the African users, it seems probable that the advantages outweighed the disadvantages. With regard to the subsequent effects of the industry upon the Nyanza tribes, no statistics are capable of providing the answer. The anthropologist and the sociologist, working in the field, may find that the after-effects of the gold-mining era lie at the roots of some of the later problems of Kenya colony. A few observations, however, readily occur.

Memories of the disturbance and of the fears of insecurity for land hamper discussions on land tenure. Wise after the event of what compensatory payment really means for loss of land, the Nyanza African will naturally be suspicious of recommendations for land-use such as are contained in the *East Africa Royal Commission 1953-1955 Report.* The absence of industrialization is now argued as a liability in the event of a distressed state of agriculture, the mainstay of the economy. But from the mining experience, where did the ex-miner find alternative employment with the decline of the industry? This is of great importance for the skilled men.

On the other side of the balance-sheet must be put the facility which the mines offered the emergent economic leader in Nyanza in his cash earnings. In a ten-per-cent sample of all African traders in the North Nyanza district in 1954/55 only one trader out of 132 interviewed stated that part of his capital for setting up in trade came from his mining savings. It seems likely that the number may be much greater if allowance is made for the fact that money earned in the mines was expended on cattle, which many traders stated they had sold in order to set up in business.

If the gold-mining industry of Nyanza is examined in relation to the gold output of the world, or the export-value contribution to Kenya colony, it must be concluded that its importance was negligible. For a few people fortunate in their prospecting it brought immediate benefits. Examined from the viewpoint of its effect upon human society, and more especially in its impact upon different races living together in disharmony, then its significance was important. Its importance lies not in its economic contribution to the impoverished settler or the opportunities it provided for the indigenous peoples; but rather in its political effects, both at the time of its impact and in the years which have followed.

1. In the period 1935 to 1953 the average annual statistics of accidents were: 33 accidents, persons killed (all races) 6 and persons injured (all races) 32.
2. Mr. Valentine of Kakamega informs me that there were no known cases of miners catching silicosis or hook-worm. No concentration of dust was found sufficient to cause silicosis.

# THE PRESENT SETTING OF THE OIL-PALM INDUSTRY

## WITH SPECIAL REFERENCE TO WEST AFRICA

By H. R. JARRETT

The story of the changing pattern of palm-oil exports during the present century is a remarkable one. The oil-palm,[1] *Elaeis guinéensis,* seems to be a native of West Africa (although some have claimed a Brazilian origin for it), and it was natural that during the first decade of this century Africa (predominantly West Africa) held a monopoly of oil-palm products—palm oil and palm kernels (Fig. 1). Yet just before World War II, Africa was contributing little more than half of the total world exports of palm oil, though she did maintain a firmer grip on palm kernel exports. How did this remarkable change come about?

It was in 1848 that Asia first saw the oil palm, when four trees were introduced purely as ornamental plants into the Botanical Gardens at Buitenzorg (now Bogor) in Java. It is not certain where these four palms came from, though they or their parents must have originated in West Africa, but it is thought that two came via Amsterdam and two from Réunion, though one or more may have come from Mauritius. In 1875 came the first recorded introduction to Malaya, when seed was received at the Botanical Gardens, Singapore, from Peradeniya (Ceylon), probably via the Royal Botanical Gardens at Kew, and in the following year came the first attempt to cultivate it on an economic basis. This was by Sir Joseph Hooker, who raised 700 palms in Labuan, on the island of Daat, from seed obtained from Kew; these palms apparently thrived, but ten years later they were removed to make room for coconuts. With this single abortive exception the tree was cultivated solely as an ornamental palm for the next 35-40 years, for local official opinion in Malaya and elsewhere was strongly opposed to any attempt to raise this as a new crop instead of the well-established coconuts and the newer crop, rubber, first received at Singapore in 1877. This brings us to 1910 when some private enthusiasts began to take an interest in the possibilities of the oil palm, and in 1917 the first Malayan plantation was laid out in Kuala Sĕlangor District. Even so, progress was very slow at first until interest was stimulated by the slump in the price of rubber which hit the rubber producers so badly after World War I, and by 1926 there were 19 oil-palm estates in Malaya (one of over 2,000 acres), chiefly in the districts of Sĕlangor (9,357 acres), Johore (1,992 acres) and Perak (842 acres), while Kĕlantan and Nĕgri Sĕmbilan had 300 acres between them. Today, half the Malayan acreage is in Johore, with Perak and Sĕlangor following.

Exports of palm oil grew from nothing at all to 195 tons in 1923 and 726 tons in 1926, while today they are running at about 55,000 tons per annum—a remarkable figure when we remember the dislocation caused by the Japanese occupation of World War II and the post-war disturbances.

Development of the oil-palm industry has been no less spectacular in Indonesia, especially in Sumatra, where cultivation was began in 1911 on the neutral and basic andesites of the east, between the high mountain ridges on the

1. Botanically the oil-palm is a form of grass. It is a member of the *Palmae* family, of which the genera *Elaeis* and *Raphia* are restricted to America and Africa (including Madagascar). *E. madagascariensis* is a related species from Madagascar, and *E. melanococca* from Brazil.

one hand and the coastal marshes on the other.[1] Thanks to the early construction of railways in the north it was the north-east which first forged ahead, while extensive bulk-storage facilities were provided, especially at Balawan-Deli, the premier port of shipment. Every encouragement was given to the new industry, in contrast to the Malayan pattern of development. During the years before World War II another railway was constructed in the south-east and production got under way there, so that by the outbreak of war the agricultural economy of Sumatra was dominated by rubber and palm oil. The output of palm kernels has never been great (10·5% total world production in 1924-28, 5·0% in 1934-38 and 4·8% in 1950-54), but the export of palm oil quickly achieved a position of world significance (11·8% in 1924-48, 38·6% in 1934-38, 22·8% in 1950-54). Fig. 1 shows the increasing share of world trade in oil-palm products won by the countries of South-East Asia (Malaya and Sumatra dominantly) during the present century.

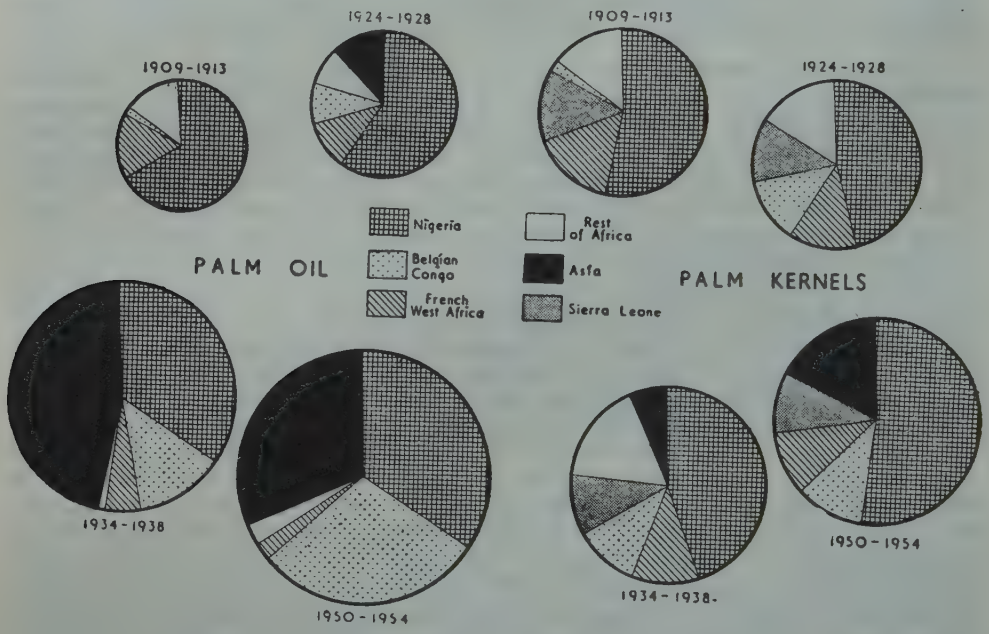


Fig. 1. Palm-oil and palm-kernel exports.

At the same time as Asiatic production was forging ahead the share of the Belgian Congo was increasing markedly, from 2·0% of world palm-kernel exports in 1909-13 to 10·8% in 1950-54, and from 1·7% of world palm-oil exports (1909-13) to 28·7% (1950-54). This expansion, of course, is largely related to the activities of the well-known *Huileries du Congo Belge,* which has established plantations. The fact is that of the three major world producers of oil-palm products, Nigeria, the Belgian Congo and Indonesia, Nigeria is the only one whose exports are not markedly expanding, while the situation of the rest of West. Africa is even less happy. Sierra Leone, traditionally an important exporter,

1. G.F. Deasy, "Localization of Sumatra's oil palm industry." *Economic geography* (1942), pp. 153-158. This article briefly examines the desirable physical background to oil-palm cultivation. See also H.R. Jarrett, "The oil palm and its changing place in the economy of Sierra Leone," *Geography* (Sheffield, 1957), pp. 50-59.

particularly of palm kernels, is falling rapidly behind (14·2% of the world exports of palm kernels in 1909-13, 9·4% during 1950-54; palm-oil exports have now virtually ceased),[1] while Ghana has never been important in this field since the rapid expansion of cocoa-growing during the last quarter of last century. The little Gambia is an insignificant exporter, while French West Africa is also diminishing in relative importance (16·0% of the world total of palm-kernel exports, 1909-13, 9·8% during 1950-54; 15·9% world palm-oil exports, 1909-13, 2·6% 1950-54).

It is not surprising, under these circumstances, that considerable misgivings are being felt in West Africa over the whole future of the West African oil-palm industry. This is no new thing; as long ago as 1928 F. J. Martin was writing, "With regard to palm oil ... the present exports from the east are still comparatively small (but) they provide the cloud, at present 'no bigger than a man's hand' which threatens West Africa."[2] As we have seen, the threat developed and

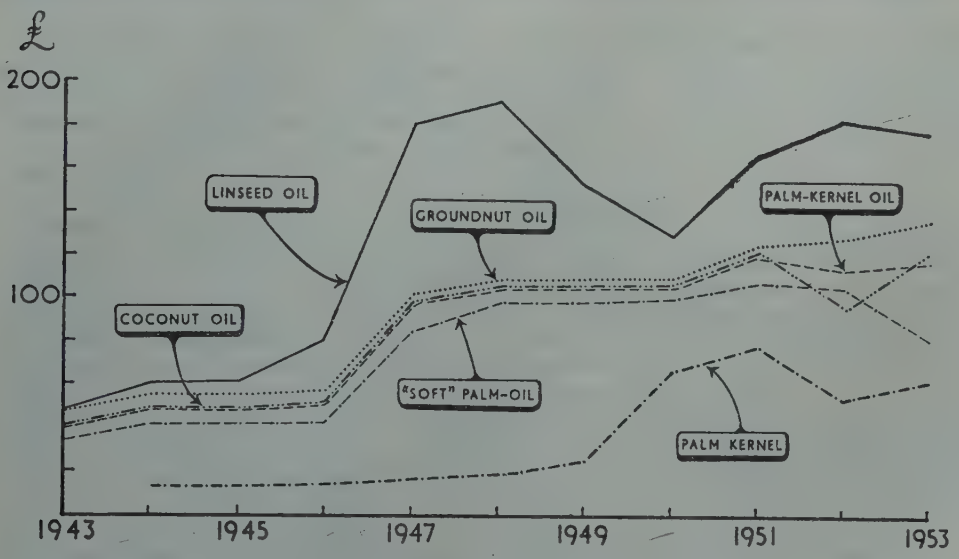


Fig. 2. Average world prices of selected fats and oils.

the "Sumatran menace" is still remembered and feared, for it is well realized that the war-time recession of Far Eastern exports was only temporary. The failure notably to expand post-war supplies is even more ominous when we bear in mind the measure of the direct financial encouragement which this producing industry has known, some measure of which can be gauged from Fig. 2 which shows the average ruling prices for selected fats, oils and oil-seeds over the post-war period. The rise in prices has been staggering, and there can be no doubt of the encouragement which must have accrued to producers. The Far East and Belgian Congo have responded; West Africa has not.

These rising prices are, of course, evidence of a strong demand for fats and oils on the world markets, but we might observe that producer countries such as West Africa have benefited from at least two other factors. The first is

1. Jarrett, *op. cit.*
2. F. J. Martin, "The oil palm industry," *Tropical agriculture,* vol. 5 (London, 1928), pp. 189-193.

that producers of primary products are attaining a higher standard of living than they have ever known, and they are now tending to retain more of their own products for domestic consumption; and outstanding example of this is India, formerly a notable exporter of oil and oilseeds, which has exported no groundnuts since 1949 though she still produces very substantial amounts. The output of such countries, is, therefore, withdrawn from the world market. In the second place, many importing countries have been prevented by shortage of dollars from

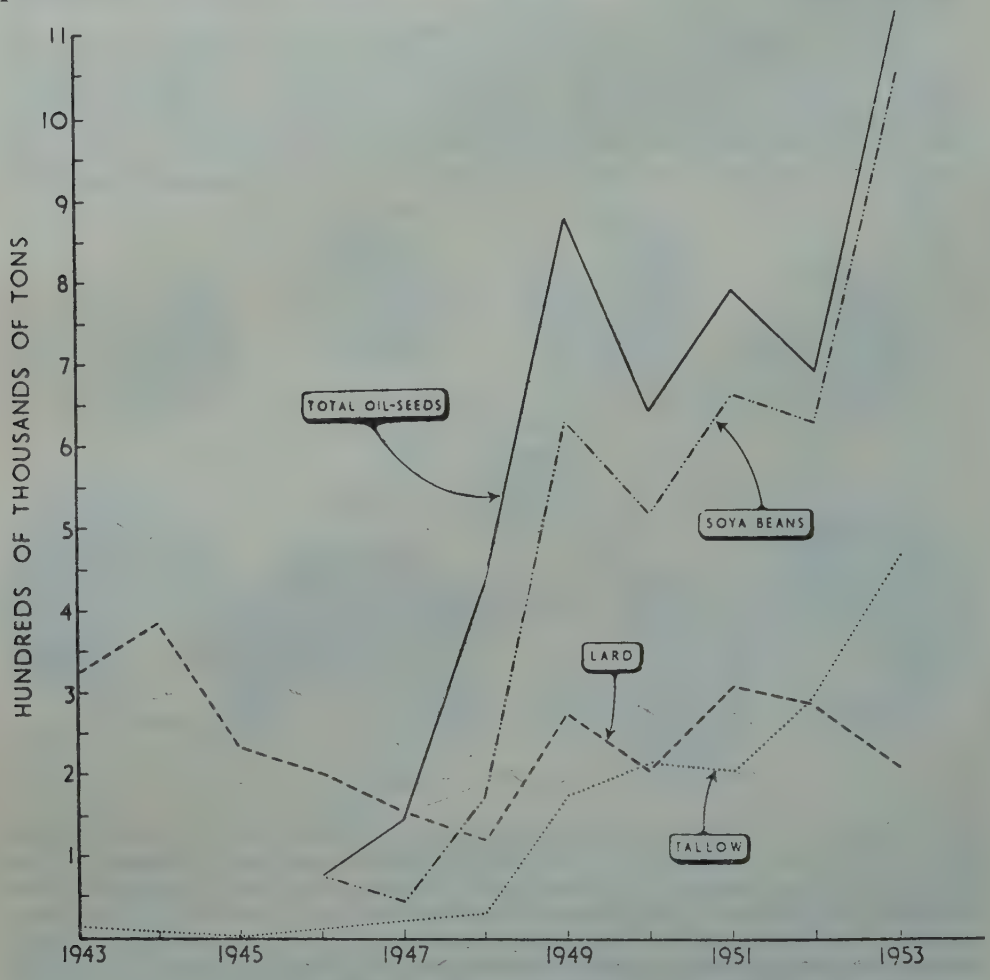


Fig. 3. Exports of fats and oil-seeds from the U.S.A.

taking oils and fats, substitutes for palm oil and palm-kernel oil, from the U.S.A. This blockage was partially concealed by steadily rising post-war exports from the U.S.A., but the situation can be in part appreciated from the sharp upward turn in U.S.A. exports in 1949, the first year of Marshall aid, which enabled these exports to march more closely with world demand. This is illustrated in Fig. 3.

It is not surprising, perhaps, that West Africa is at last realizing that her traditional grasp of the palm-oil and palm-kernel markets, though temporarily

restored by World War II, is again in serious danger, and voices are not lacking which point out the serious threat of a return to the dark pre-war days of depression and crushing competition. The threat is now, if anything, perhaps more serious than ever, because the range of substitutes is continually increasing; for instance, in 1949 it was estimated that at least 350,000 tons of fats were being saved annually in the U.S.A. alone by the use of soapless detergents. It is one thing to appreciate the reality of the threat, however, and another matter to set about removing it. Can we point to reasons for the disappointing West African response as a preliminary to setting the industry on a firmer basis? I would suggest four: (1) the overall increase in prosperity has attracted labour away from the traditional oil-palm industry; (2) the poor quality of West African palm oil has in the past placed it at a marked disadvantage *vis-à-vis* the superior Far Eastern product; (3) wasteful methods of extraction employed; (4) the marked predominance of trees and fruit of inferior quality, and the hitherto scant attention paid to cultural practices.

(1) The overall increase in prosperity. This can be crudely illustrated by general statistics. For instance, the total value of exports from Sierra Leone in 1913 amounted to £1,376,602; in 1954 it was £11,000,876.[1] Prothero points out that the value of Nigeria's export trade was in 1947 four times the 1939 figure, and has since increased by a further 300%;[2] the 1910 export value was £5,258,000, while the 1953 figure had risen to £125,349,000. These are substantial increases, even allowing for depreciation in the value of money, and they represent only a part of the increased wealth of West Africa today. This increased prosperity has come about by the development of new forms of economic activity, and it follows that the labour force which an old-established industry like the oil-palm industry can command must be decreasing. In 1928 palm kernels and palm oil accounted for 78·1% of the value of the exports of Sierra Leone, whereas in 1954 the figure had fallen to 34·8%, largely because of the recent increase in mineral exports.[3] In 1910 172,997 tons of palm kernels and 76,851 tons of palm oil were exported from Nigeria, while the third heaviest export tonnage was that of cocoa, 2,932. Comparable figures in 1953 were 403,000 (palm kernels), 201,000 (palm oil), 327,000 (groundnuts) and 104,671 (cocoa). Instead of being dominated by the oil-palm trade, the exports of Nigeria are shared mainly between four main and a whole number of lesser exports. The main ones are palm products, 28% by value (chiefly from the Eastern Region), cocoa, 20% (chiefly from the Western Region), groundnuts, 20% (chiefly from the Northern Region) and minerals, 9%. The situation in Sierra Leone is being further complicated by the recent diamond rush, for alluvial diamonds have been found over wide areas in the Protectorate. There is naturally a rush to dig, and the result is the wholesale neglect of agriculture. Few inland rice swamps are now being cultivated, local foodstuffs generally are scarce and expensive, while it is necessary to import rice and palm oil.[4] Farmers will not bother to harvest the oil-palm bunches growing above their heads. The situation is serious, as the cost of living soars on the wings of the new diamond money, as labourers are brought in from surrounding French territory, and as respect for tribal sanctions and modern law alike is destroyed in the filth and poverty of the squalid diamond-diggers' hovels. No solution of

1. Some further comparative figures are given in H.R. Jarrett, "Recent port and harbour developments in Freetown," *Scottish geographical magazine* (1955), p. 160.
2. R.M. Prothero, "Recent Developments in Nigerian export crop production," *Geography* (1955), p. 18.
3. H. R. Jarret, "Lunsar. A study of an iron mining centre in Sierra Leone," *Economic geography* (Worcester, Mass., 1956), pp. 153-161.
4. Jarrett, "The oil palm.....," op. cit.

this particular problem is in sight. In so far as it means that each West African territory is now less dependent upon one particular commodity, this new prosperity is all to the good, and the lack of response of palm-oil and palm-kernel production to a strong world market is undoubtedly in part simply because of an inadequate labour supply. Further consideration of this topic would lead us into a subject worthy of special study, but it is a situation which clearly admits of no easy solution.

(2) One of the important factors which has put West African palm oil at a disadvantage in earlier days has been its poor quality. It is well known that if sufficient care is not taken in treating the palm fruit the troublesome "free fatty acid" (f.f.a.) forms as a result of chemical changes, so that the quality of the oil is impaired. The poor quality of a product which often contained 40% f.f.a., and not infrequently up to 60%, counted heavily against it in pre-war days when importers could purchase the more carefully prepared high quality Far Eastern oil. For the first time real efforts are being made in West Africa to deal with this situation, through the agency of the Oil Palm Marketing Boards. These Boards guarantee a stated buying price at the beginning of a season for the whole of that season, and this has the advantage of eliminating the short-term price fluctuations so troublesome in pre-war days. They have generally operated at a profit during a period of rising prices, though in 1953 the Nigerian Oil Palm Marketing Board worked at a loss because of price depression.

These Boards have introduced a system of differential payments for different qualities of oil, and inspectors grade all oil which is shipped. In 1954, for instance, £65 per ton was paid by the Board to producers for "Special" grade palm oil, with a free fatty acid content not exceeding 4·5%, but only £33 per ton was paid for grade 3 oil (f.f.a. up to 30%). As a result of this measure, production of the "Special" grade has increased in only four years from 0·22% of all Nigerian oil produced in 1950 to 55·9% in 1953, and the interesting feature is that this has been done for the greater part by present producers using the traditional methods, though greater care is now obviously being taken. It does show that the present producer is not necessarily at a disadvantage *vis-à-vis* the plantation and large scale producer.

(3) Much palm oil is wasted in extraction, as the hand methods generally used may extract only 45% of the oil contained in the fruit, whereas simple hand presses can extract 65% and upwards, and Pioneer Mills[1] about 85%. It is estimated that because of these wasteful methods, the average yield per acre in Indonesia is 25% greater than in Nigeria. Encouragement is therefore being given to the establishment of Pioneer Mills and hand presses, of which there were probably over 5,000 in Nigeria in 1953. A Pioneer Mill can handle five tons of palm fruit per day and produce 350 tons of "Special" oil per annum if the fruit treated is fresh and unbruised. Kernels will, of course, be produced concurrently. There was at first considerable opposition to the setting up of these mills, of which 78 were erected by 1953, as the present producers feared for their livelihood, while an unexpected complication arose over the kernels. These had always been the perquisite of the women who cracked them and sold them for pin money—so, incidentally, producing West Africa's palm-kernel exports! When we remember that about 1,000,000 kernels are needed for one ton, and that the export from British West Africa runs at about 45,000 tons annually, our minds are rather dazed as we try to imagine the vast amount of patient manual labour involved in cracking all the nuts, each one separately between two stones! Signs

1. Prothero, *op. cit.*, p. 23

are not lacking that the women (and children, who also help) of West Africa will not always be content to perform these tedious tasks.

To return to the question of the mills, the women did not at first take kindly to the possible loss of this perquisite. Kernels are often used as personal "banks," stores being accumulated and various amounts being sold from time to time to supply money as needed. There were hostile demonstrations against the mills, but the situation has now quietened down and the mills are accepted; many mills for a small charge now crack nuts brought in by women from surrounding areas.

Not everyone is convinced that the mills can be a sound commercial proposition without plantations. It has been pointed out[1] that their average extraction rate is no higher than that from a competently operated hand press, while there are grave doubts as to whether they can be fed to capacity by a peasant economy. During the 1952-53 season the 41 mills in the Eastern Region of Nigeria were handling an average of 2·6 tons of fruit per working day, against the four considered necessary for economic working. The normal range of supply to the mill is only seven miles by road and slightly more by river, under present conditions.

It may, therefore, prove sounder to encourage still further the hand presses, which are already very popular in Sierra Leone. There is also a very great demand for small nut-cracking machines, driven by a single-cylinder petrol engine. We are clearly in the early stages of a revolution in palm-oil and palm-kernel production methods, and much will depend upon the success or otherwise of the various experiments now being tried.

(4) It has for long been generally recognized that over large parts of West Africa palm-oil production has been handicapped by the poor quality of the indigenous trees, while few attempts have been made to cultivate the palms systematically or scientifically. Only sporadic attempts were made to deal with this undesirable situation until after World War II, and in 1951 an ordinance was passed by the Nigerian legislature for the setting up of the autonomous West African Institute for Oil Palm Research (WAIFOR), which is now supported by funds from Nigeria, Sierra Leone and the Gold Coast. Before examining some of the work now being undertaken it will be profitable to say something of the varieties of oil palm and their fruit (Fig. 4).

It will be seen that there are considerable variations among the different fruits. The *macrocarya* has the thickest shell, 4-8·5 mm. thick, and the *tenera* the thinnest, 1-2·5 mm: in between comes the *dura,* 2-5 mm. As the fruit does not vary greatly in size it will be clear that this is an important point, for about 50% of the total weight of a *macrocarya* fruit is fairly useless shell, whereas the corresponding figure is only 30% with *dura* and 10% with *tenera.* The *pisifera* is interesting and unusual, for while it fruits the fruit rarely ripens; it normally rots away. When it does ripen, however, it has no shell, but its chief use is for cross-pollination, the male flowers being used for this purpose.

The names given above have now superseded earlier names which were based upon the palm itself rather than the type of fruit. For instance, the old "Angola" variety originated from Angola and was characterized by heavy bearing, but the actual fruit was mixed in type. One extremely interesting variety was

1. By Miss A. Martin, in an unpublished manuscript. "The oil palm economy of the Ibibio farmer." My thanks are due to Miss Martin who has allowed me to see this manuscript.

the "Deli", which originated in the Far East. It must have stemmed from the four Buitenzorg palms, and the odd thing is that, when introduced into West Africa, it has retained its individuality; it has not "reverted to type." It bears fruit chiefly of the *dura* type.

The type of fruit which you will wish to produce will depend, of course, upon the purpose for which it is required. For the production of palm oil, which comes from the mesocarp, the *tenera* is preferable, but for kernel production the *dura* is better. Considerable attention is now being given to the breeding

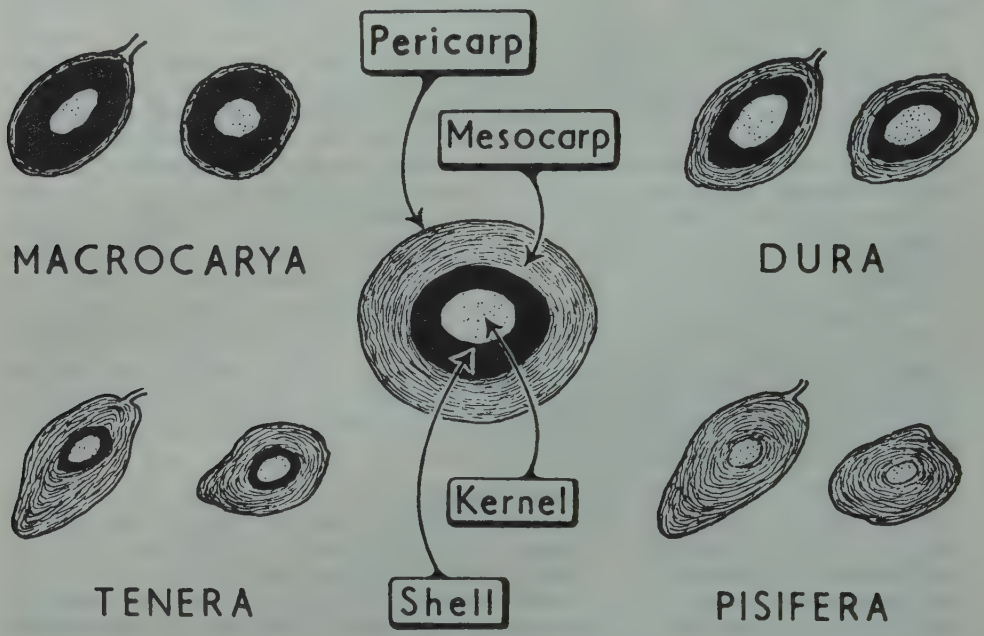


Fig. 4. The chief types of oil-palm fruits.

of these strains, therefore, but this is by no means as easy as may be supposed. This is unfortunate, for it is not possible to tell what sort of fruit an oil palm will bear until the fruit can actually be examined. The theory of crossing is simple enough, following the well-known Mendelian laws, but in practice things do not work out accordingly. The following statistics illustrate this and have reference to crossing experiments recently carried out at Benin.

| CROSS | DURA x DURA | | DURA x TENERA | | DURA x PISIFERA | |
|---|---|---|---|---|---|---|
| PROGENY | DURA | TENERA | DURA | TENERA | DURA | TENERA |
| PERCENTAGE EXPECTED ACCORDING TO MENDELIAN LAWS | 100 | 0 | 50 | 50 | 0 | 100* |
| ACTUAL RESULTS | 90·3 | 9·7 | 72·6 | 27·4 | 58·1 | 41·9 |

* This means that the *tenera* is a hybrid of *dura* and *pisifera*.

One might be forgiven for supposing that the Mendelian laws are held in abeyance as far as the oil palm is concerned, but further reflection will suggest that natural cross-pollination was the upsetting factor, despite the care taken over

the experiments. The difficulties besetting the breeder will be clear enough when we realize that there is every chance of unwanted wind-blown pollen (and the air is full of it over wide areas in West Africa) acting as the fertilizer. That this did occur was suspected when it was found that Angola palms in Sierra Leone were in some cases suffering from crown disease which is peculiar to the Deli; there must have been cross-pollination with the Deli strain.

Despite these difficulties, however, there is clearly considerable benefit to be gained if the right varieties of palms are planted, as we have already seen. This is further emphasized by measurements taken on the Njala plantation in Sierra Leone over the year 1932-38 inclusive, when the average annual yields of fruit of different species were as follows.[1]

| *Species* | *Kg. per bearing tree (average)* |
|---|---|
| Kawei[2] | 15·2 |
| Henoi[2] | 11·1 |
| Angola | 36·3 |
| Deli | 11·9[3] |

Other questions which seem to be linked with the different varieties are those of the sex ratio and the abortion ratio, though not a great deal is yet known about them. Some varieties, however, seem to bear a greater proportion of male and some of female inflorescences, and for high yield the latter are obviously preferable. The Angola seems to come into this class. On the question of abortion, we have already mentioned the extreme case of *pisifera,* with almost 100% abortions, but every palm sometimes produces "blind" heads, when the female inflorescence flowers and may even proceed for a few weeks to set what looks like normal fruit, but after a certain stage the bunch dies.[4] This regular abortion can hardly be explained by fungal attack, and we need to know more about it.

Disease, of course, takes a regular toll of the harvests, though fortunately nothing as virulent and deadly as, for instance, the swollen shoot which afflicts the cocoa plant is known to attack the oil palm. But various deficiency diseases have been recognized, such as orange frond (insufficient magnesium) and confluent orange spotting (lack of potassium), though these diseases also bear some relation to light intensity. For instance, the oil-palm leaflets (pinnae) are arranged in two rows on the mid rib, an upper and a lower, and the upper leaflets which catch more sunlight always contain smaller magnesium reserves than the lower which may have up to 25% more. The upper pinnae are always affected first by disease, therefore, but it is not unknown for a frond which is noticeably affected to be perfectly free from the orange frond effect where an overlying frond happens to shade it. There are also suspected zinc, copper and molybdenum deficiencies in West African soils, and results of all these may well be superimposed so that it is not easy to pick out individual deficiency diseases. It is notable, however, that palms occupying the sites of former house compounds are often of outstanding vigour, sometimes in marked contrast to those immediately around. This may well be due to the presence of a relatively stable organic fraction able to retain plant nutrients in an available form without loss by leaching, while there will

1. Calculated from data recorded in the *Annual report* for Sierra Leone for 1938.
2. Local species bearing *macrocarya.*
3. Yield after only 3 years of bearing.
4. F. C. Deighton, *Report on the ... oil palm plantation at Njala, Sierra Leone* (Freetown, 1929).

certainly be mineral supplements on such sites from the general debris left by the former inhabitants.

Another interesting observation is that in any batch of palms probably about 10% of them will be "unthrifty" (constitutionally delicate). No cause is known for this, but probably hereditary defects produce delicate palms which are unable to make full use of the nutrients available. This is not related to soil nutrient status as unthrifty palms can be recognized on good soils. The non-committal term "plant failure disease" covers defects of this kind, though unthrifty palms, as we might expect, show a greater susceptibility to other diseases.

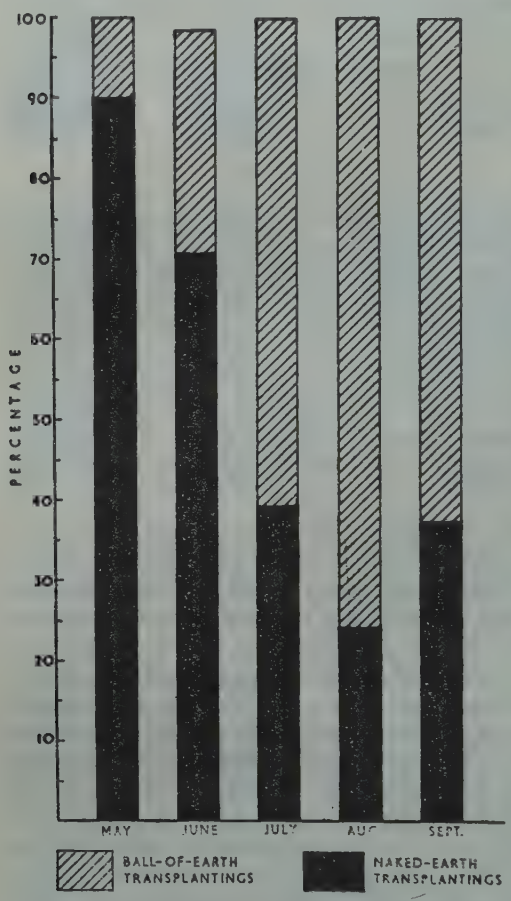


Fig. 5. Results of planting-out experiments. Successes are shown as percentages of total transplantings.

Much experimental work is also being carried out with regard to germination and planting out, for it has become quite clear that far earlier yields can be expected if care is taken; whereas a wild palm may not come into bearing until its fifteenth year, a cultivated palm should yield in its fourth year of life. This clearly represents a tremendous gain. Attention is being paid especially to the comparative results of transplanting from the nursery with naked roots, pruned or unpruned, or with a ball of earth left adhering to the roots. From May until September, 1950, 2,000 seedlings were planted out at Benin, 1,000 with naked roots, 1,000 with a ball of earth, and Fig. 4 shows the results observed in May the following year.[1] The overall advantage of the ball-of-earth method is obvious, though equally clearly early planting has much in its favour.

Unfortunately the ball of earth method is extremely arduous, as the seedling with its ball will weigh anything up to three-quarters of a hundredweight. This may have to be carried an appreciable distance as a head-load, while the greatest care must be taken not to break the ball. Recent experiments carried out in Sierra Leone suggest that equally good results may be obtainable by pruning the roots of the seedlings about a month before they are removed from the ground for transplanting, which is then done with naked roots. Confirmation of this is still being sought, but we have seen from Fig. 5 that there are grounds for thinking that if such seedlings are planted out early in the season the results may well be as good with naked roots as with the ball of earth.

1. Data from F. W. Toovey, "Field planting of oil palms," *Journal of the West African Institute for Oil Palm Research* (1953), p. 71.

Bitter experience has brought home the fact that the most careful measures must be taken to protect the seedlings against rodents, which will attack palms up to three years old, gnawing through the tough leaf bases to get at the soft tissue at the heart of the plant. Usually the apical bud is then completely eaten away so that the palm inevitably dies. The most effective protection consists of wire collars—"rodent collars"—made of strong wire-netting completely surrounding the seedlings; these hollow cylinders should be about 24 in. high and must be buried two or three inches in the ground. A recent experiment has yielded very interesting results.[1] Three blocks of 420 palms each were given anti-rodent protection—one block with rodent collars, one with a fence all round the block, while the palms in the third simply had their bases tarred. A fourth similar block had no control; in this block 23·3% of the palms were attacked, and this accorded well with experience elsewhere that a quarter of one's seedlings may well be lost through rodents. The interesting thing was that 36·7% of the tarred trees were attacked, so that tarring seemed to encourage the pests! Of those fenced, only 1·2% were attacked, and of those with collars only 0·5%. Although the initial expense of collaring is appreciable, collars can be safely removed from three-year-old palms and used again, so that recurrent costs are not high.

Enough has perhaps been said to show that, at long last, serious efforts are being made in West Africa to combat the "Sumatran menace." There are grounds for a guarded optimism, as we have seen, but in any case the results of the present efforts will have the most important consequences for the Far East, for West Africa, and for the consumer countries of the whole world, and will be eagerly observed by all whose interests are bound up with the fate of *Elaeis guineensis*.

1. Toovey, *op. cit.*, p. 73.

# AGRICULTURAL POTENTIALITIES IN NORTHERN AUSTRALIA

By C. O. OLSEN

When Professor Griffith Taylor published an article in the American *Geographical Review* for August 1919, the editor of that magazine wrote the following introduction:—

"To the politician who makes a flying visit to tropical Australia in the most favourable time of the year, there appears to be 'no reason why a thriving white population should not fill the tropical areas'. The Government official, usually engaged in promoting some branch of industry, has his accounts buried beneath a mass of advertising literature. It is useless to consult the squatter living wholly out of doors, and following the most healthful occupation in the world; his opinion is valuable only as regards the essential conditions of pastoral life. In view of these difficulties it might not be amiss to study the facts comparatively and in a scientific spirit. What is tropical Australia? Will it support a large white population? What are the experiences of whites in similar climates elsewhere?"

Such was the problem to be discussed thirty seven years ago when Griffith Taylor produced the following figures on settlement inside the tropics:—

TABLE 1: AREAS AND POPULATIONS IN TROPICAL LANDS

1915

| STATE | TOTAL AREA (SQ. MILES) | IN TROPICS | | POPULATION | PERCENTAGE IN TROPICS |
|---|---|---|---|---|---|
| | | NUMBER | PERCENTAGE | | |
| QUEENSLAND | 670,500 | 359,000 | 54 | 677,000 | 24 |
| N. TERRITORY | 523,600 | 426,000 | 81 | 4,500 | 90 |
| WEST AUSTRALIA | 975,900 | 364,000 | 37 | 323,000 | 1·5 |

1935

| STATE | TOTAL POPULATION | IN TROPICS | PERCENTAGE IN TROPICS |
|---|---|---|---|
| QUEENSLAND | 972,000 | 185,000 | 19 |
| N. TERRITORY | 5,138 | 4,870 | 95 |
| W. AUSTRALIA | 448,000 | 3,324 | 0·7 |

Tropical Australia is divided politically among the three divisions of Queensland, Northern Territory and West Australia; and constitutes 38·6% of the area of the Commonwealth. The areas of the tropical regions in each state are given in Table 1. It is noted that in 1935 the total population was only 193,000 and it occupied over one-third of the total area of Australia. Of these 193,000 living in tropical Australia, about 90% lived in Queensland. Indeed the great majority lived right along the "Sugar Coast" and to-day in 1957 the pattern of population distribution has not changed materially.

The aim of this article is not to prove, as Griffith Taylor set out to do, that white people (Australians) can live effective and vigorous lives in tropical areas such as northern Australia. This has naturally been taken for granted and many periodicals and scientific journals, have already treated this question in exhaustive fashion. Most of the writers have reached the same conclusion that white people are on the whole capable of leading a life in the tropics which does not differ fundamentally from that of their southern neighbours.

Assuming then that Australian people can, and do lead healthy normal lives in these hot regions, the writer proposes to review existing agricultural industries and to discuss opportunities for expansion and development of new ones in this region. It has often been emphasized by geographers, agricultural

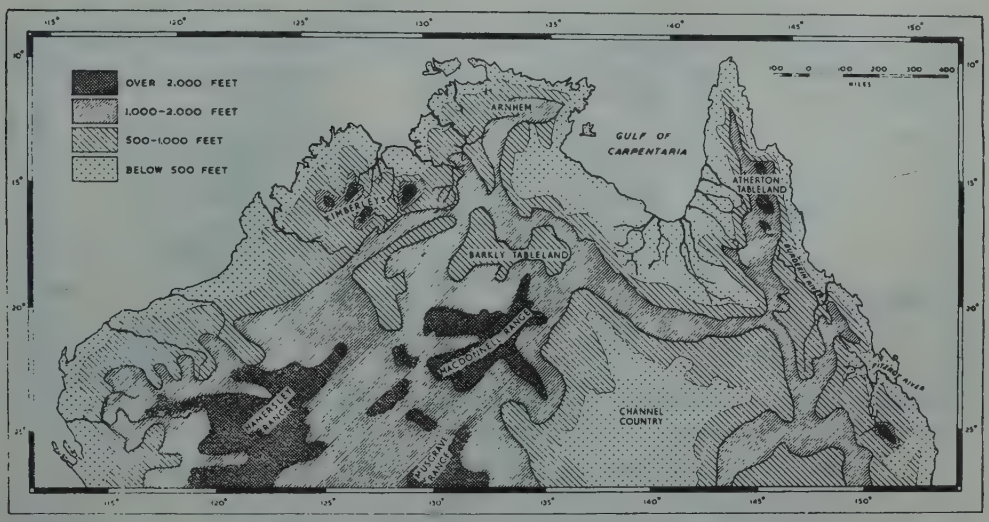


Fig. 1. Generalized relief and drainage of North Australia.

advisers and other experts that Australia lacks one essential ingredient for successful production of any tropical product—there is no convenient and readily available supply of cheap labour such as is found in Java, Malaya or the Philippines.

## CLIMATE OF NORTHERN AUSTRALIA

The agricultural possibilities of a region may be regarded as a product of the climate and soil. As far as climate is concerned, the chief elements for successful growing of agricultural crops will be rainfall and temperature, but aspects such as humidity and hours of sunshine also enter into the matter, particularly with tobacco and sugar-cane production. Critical soil properties must be fertility, moisture-holding capacity and structure. Man can modify the natural effects of climate by using irrigation, by choosing the best time for planting, and he can also modify soil characteristies by using fertilizers, adding fresh organic matter, improving natural drainage. All these or many of them are dependent on the financial aspect. In most cases in the tropics finance will be a limiting factor, in which case full exploitation of the natural resources of a region has to be achieved with a minimum of expense.

The rainfall of Northern Australia is predominantly a summer, low-pressure monsoonal type, but it must be remembered that the monsoonal effect deminishes

rapidly on passing inland, and the length of the effective growing season similarly declines.

Darwin has an annual rainfall of 60 in. concentrated in the hottest six months, and with an effective growing period of about the same length. Katherine, 200 miles farther south, with an average yearly rainfall of 40 in. has only three months for growing crops. Farther south is Daly Waters, with an annual rainfall of 26 in. but a growing season of little more than two months. On the east coast in North Eastern Queensland, Ayr with 41 in. of rain every year has a four-month growing season. Charters Towers, with a yearly rainfall of 24 in. has about three and a half months, while Clermont with 26 in. of rain has three months for successful crop production.

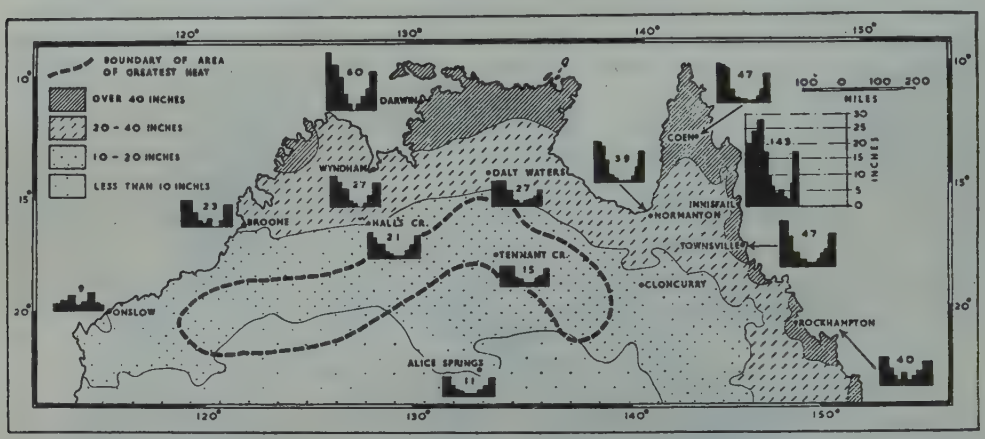


Fig. 2. Rainfall of North Australia. Numbers above graphs indicate total annual rainfall.

The climate of northern Australia is such that the possibilities for agriculture are virtually limited to summer-growing crops where heat and moisture come simultaneously, except for an area in the south-east corner, stretching from Rockhampton through the Central Highlands north-west to Nebo. Here there is a winter component in the rainfall, which would allow, with the summer to follow, a crop of winter cereal being grown for green feed or for hay purposes, and occasionally as a grain crop. In the Burdekin area some winter cereals are grown under irrigation, and on the Atherton Tableland oats are grown for green feed. Emphasis over the remainder of the region must be laid on the recognized summer crops—sugar-cane, tobacco, peanuts, the sorghums, maize, cotton and tropical fruit as major crops, along with potatoes, green-manure crops and tropical pastures. It must be clearly borne in mind that in the tropics, with the use of irrigation, it would be possible to produce these normally summer-growing crops *out of season* by planting in autumn or early spring. This is most important, as it allows a spread in agricultural production to give an almost all-the-year-round yield for any particular crop. Advantage was taken of this during the war years when the potato crop from North Queensland made up the shortage which had developed in southern Australia.

## SOILS

Soil distribution will determine to a large extent the agricultural potential of northern Australia. Soils must be considered from the point of view of dry

farming and irrigation. In dry-farming systems the capacity of the soil to absorb and hold water is all-important, unless the rainfall is high enough, as in northern Queensland, to provide enough water every month of the year. Under irrigation, ability of the soil to absorb water and permit adequate drainage is very important. Where irrigation is available, the lighter soils, such as sands or sandy loams (found often on levee banks) can be cultivated, and in fact are necessary for producing tobacco leaf of good colour.

Throughout northern Australia there is generally a marked lack of phosphate in the soil. A map of the phosphate status would show adequate supplies in the black-soil regions of the Central Highlands, in the red-loam soils of the Atherton

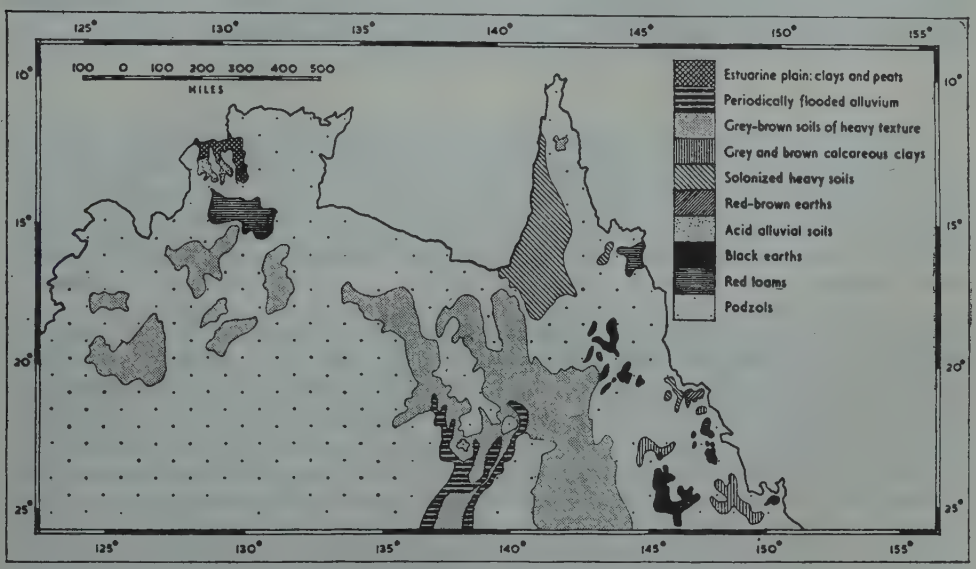


Fig. 3. Potential agricultural soils of North Australia.

Tableland and in most of the open Mitchell-grass downs-country south of Julia Creek. Above this line and stretching right across the Northern Territory and West Australia, there is a soil belt in which serious phosphate deficiency limits plant growth, and heavy and regular doses of this mineral are needed to induce growth at all. This phosphate deficiency may eventually be the critical factor in economic exploitation of the agricultural soils of northern Australia. Often there is a deficiency of nitrogen as well, but by using leguminous crops in rotation, plus some applications of nitrogenous matter, this handicap can be surmounted. In tropical conditions where there is continuous crop cultivation, soils, especially those of stream levees, lose their structure, and this necessitates crop rotation. Christian quotes peanut growing on the Katherine River, where first yields were as high as 2,400 lb. per acre, but later on the same ground yields dropped to 600 lb., using the same methods of cultivation.[1] This clearly demands a system of crop rotation. Fig. 3 gives an idea of potentially suitable agricultural soils in northern Australia. Here only a few comments will be made.

1. C. S. Christian, *Some scientific aspects of development in northern Australia, Commercial Bank of Australia Publication* (1949).

*Soil Belts*

They include a wide range of Great Soil Groups including Grey and Brown soils of heavy texture, black earths, red-brown earths, podsols, grey and brown calcareous soils, red loams, red earths, solonized soils, lateritic red-earths and immature soils such as recent alluvials. Of these the grey and brown soils are probably the most important group for agriculture. In Queensland they occupy a huge area bounded roughly by Barcaldine, Hughenden, Normanton, Burketown, Cloncurry and Boulia. There is an isolated patch of 190,000 acres at Wrotham in the Cape York Penninsula. There are also deposits on the Barkly Tableland, in Northern Territory, and the Ord River district in the Kimberleys has also large deposits. Black earths are found only in Queensland. Red-brown earths are not extensive, but are found in the Burdekin valley around Mt. Leslie, where 50,000 acres could be cultivated by dry farming or by irrigation.

*Soils*

Podsols are the most extensive of all soils in Northern Australia but are not commonly used for agriculture, save for cane-growing and tobacco production. Another valuable soil group for future use is the grey and brown calcareous soils which Prescott brackets with the black earths. They are found in the Central Highland north of Capricorn, and are usually covered with brigalow and yellow-wood timber.

This is a very promising soil for agricultural use, but there is some seasonal flooding in the Comet and Isaacs River valleys. The red loams occur in Queensland and are used for sugar-cane, maize, peanuts and dairying. The main centres are found at Innisfail (highest annual rainfall in Australia, the Atherton and Evelyn tablelands, and in the Boiling Springs area north of Cooktown). Red earths occur in isolated patches but are mainly found in the Mareeba-Dimbulah area, the McIvor River and around Chillagoe in Queensland. They are usually freely drained, but would respond under irrigation. Solonized soils occupy unfortunately a large area and are generally only of limited agricultural value, but might be used with irrigation. The Burdekin Valley has extensive areas of such soils which could be used for cane-growing and for pasture improvement.

Lateritic red soils are widely spread. Highly leached and of poor structure they are relatively infertile. They could be used with irrigation or in high rainfall areas, always provided the necessary fertilisers could be applied cheaply. Large stretches are found between Mt. Isa and Comooweal in Queensland, and at Brocks Creek in Northern Territory.

The alluvial soils in North Queensland are almost fully utilised for cane growing and pasture growth, but some levee country in the Burdekin Valley, along the Bowen River in the Upper Herbert, Endeavour, McIvor, Morgan Gilbert, Gregory and Nicholson Rivers can still be taken up. Distance from, and paucity of, markets are two very formidable obstacles to be overcome. Those soils in the Burdekin Valley are being brought under cultivation as water for irrigation becomes available.

Acid alluvial soils occur in an extensive expanse in the Northern Territory in the flood-plains of the Adelaide and South Alligator Rivers and their tributaries. Commonly known as bulldust plains, they have possibilities for rice production.

## AGRICULTURAL CROPS AT PRESENT GROWN IN NORTH AUSTRALIA

It would be fair comment to say as a preamble, that northern Australia must always remain predominantly a pastoral country. Over most of this region, rainfall reliability and soil fertility do not encourage the development of permanent agriculture. It must also be clearly borne in mind that successful crop growing in northern Australia depends not only on the ability to grow and harvest satisfactory crops, but also on the economic factor—the availability of markets and of cheap and efficient transport facilities. This problem is particularly vital to the beef-cattle industry where stock may have to be driven 500 miles on the hoof in N.W. Australia or longer distances from Northern Territory to the Queensland railway system on the east coast. Under present conditions the northern market is limited, transport facilities are grossly inadequate, and costs of production are high. This obviously places a premium on high-value, small-bulk commodities (e.g., wool), and so only high-value export crops can be grown, or crops for local consumption by the stock industries.

### *Sugar*

As sugar employs most of the 250,000 people living in tropical Australia, it is relevant to discuss the possibilities of future expansion in this industry. As one survey said years ago, "Australia within the tropics is sparsely populated, apart from the sugar growing coastal districts". This holds true today. H. W. Herbert, writing of the Australian sugar industry, had the following comments to make in 1936: "The Australian sugar industry has some remarkable features. It is the only sizeable cane sugar industry in the world operated solely with white labour, and has resulted in the most successful settlement of white men in the tropics ever. It is spread out in 9,000 farms along 1,200 miles of coast from the Clarence River to Mossman, north of Cairns, yet in some ways it is the most tightly organized industry in Australia. Its workers have much higher incomes than sugar workers in any other country, except Hawaii and Louisiana, which sell all their sugar on the protected American market. Moreover Australian farmers get a high yield of sugar per acre—over three tons compared with less than one and a half tons in 1900." But the sugar industry of northern Australia is in a unique position. It has been established for political and strategic motives, and the economic consideration is a secondary consideration. A constant ferment of technical improvement over the past seventy years or more has gradually transformed the industry into something vastly different from what it was with its Kanaka labour, its diseased and pest-ridden fields, and its 250 mills mostly small and inefficient. This industry therefore is in a "privileged" position because of its high strategic value, the proof that Australia is settling her open empty tropical regions. What of future expansion and development? In 1950 a Royal Commission assessed the future possibilities of the sugar industry, basing its findings on a total Australian population of between ten and a half and eleven million, and a consumption of refined products per head of population to give an Australian market of 580,000-600,000 tons of raw sugar by 1962. This figure required an extra production in Queensland of 134,000 to 150,000 tons of raw sugar by the same date. The Commission stressed the need to develop new areas of high fertility rather than to use more convenient inferior marginal land. In the course of its survey it made the following specific recommendations:—

1. Duplication of the Tully Mill to make use of additional good quality land including 11,000 acres in the Mission Beach Area, and 8,160 acres at Jarra Creek. The Macknade Mill at Ingham to be duplicated to crush cane from 11,000 acres of good sugar country in the Abergowrie and Dalrymple Creek districts.

2. With irrigation some 40,000 acres could be utilized for additional cane growing, but irrigation is essential.

3. The Atherton Tableland would no doubt grow successful cane crops, but is at present being used effectively for dairying and maize production.

4. Other areas where sugar-cane growing is a highly feasible proposition are Silkwood (29,000 acres), Home Hill (17,000 acres) and some 58,000 acres of elevated land in the Mt. Leslie area when the projected Burdekin Irrigation Scheme has been completed. The Burdekin River delta could also be used for cane growing.

This report deals only with the findings for Queensland, which produces 98% of Australia's cane. There is no doubt that sugar is the pioneer crop most suitable for developing new Australian tropical areas, and the Kimberley region in the North-West of Western Australia should also receive due consideration. It is not only the cost of establishing new mills and transport facilities which must be considered, but also the necessary research and quarantine facilities, which Queensland already possesses. Recent developments in overseas sugar-producing countries may well mean that no fuller expansion of the Australian sugar industry can take place for some years to come.

*Rice*

There has been much discussion recently regarding development of rice in tropical Australia. Rice is a tropical or subtropical crop, but at present all Australian rice production has been developed in the temperate regions (the Riverina) of Australia, where irrigation and suitable soils have resulted in higher yields per acre than are found anywhere else in the world. The economic factor is upsetting the rice economy in the Riverina for farmers are now switching from rice-growing to fat-lamb production, because of the more profitable returns and because water requirements are less than those needed for rice culture. Consequently it may be in the interests of these southern areas to cede rice growing to the tropics and make the water, at present used for rice, go farther by developing pasture growth. However, there is much room for rice production in northern Australia.[1] Clark has stated that there is a serious world shortage of rice caused by havoc and dislocation of producing areas and of populations as a result of the war. At present many Asian countries have switched in part to wheat, but, when rice prices fall sufficiently, consumption is expected to rise considerably. Clark goes on to say that in the immediate future the crux of the rice problem lies in restoring the consumption levels which prevailed in Asian countries before the outbreak of war in the Pacific (probably 1 lb. per person per day in regions where rice is the staple diet), and maintaining them at this level in the face of further population growth. Australia with a surplus for export is in a favourable geographical position to take advantage of this expanding market.

Rice may be grown under two systems of farming—upland varieties can be grown under natural climatic conditions, and swamp varieties under full or partial irrigation. Swamp varieties generally are more prolific than the upland types, and preference is given to these if enough water or rainfall is available. Swamp varieties have been grown exclusively under irrigation in South Australia. The Queensland Department of Agriculture and Stock has conducted trials with upland varieties during recent years at the Bureau of Tropical Agriculture, South Jolinstone, and one variety, ***Prelude,*** has proved very successful. The following statistics give some indication of this: in 1953, 26 cwt. per acre were obtained

1. J. M. Clark, *Quarterly review of agricultural economics,* vol. 6, no. 4 (Canberra, 1953).

with the addition of 194 lb. of sulphate of ammonia and 293 lb. of superphosphate per acre, but without irrigation. These varieties could obviously flourish in high rainfall areas from Ingham to Mossman, and, moreover, an advantage is that no capital need be expended on irrigation headworks or running costs. Experiments by the CSIRO in the Kimberleys in Western Australia seem to show that the swamp varieties, which yield so well in southern Australia, do not give such high yields when taken into the tropics, and one must conclude that much varietal selection and breeding yet remains to be carried out to provide suitable strains in these northern areas.

Fig 4. Duration of growing season in parts of North Australia (showing date of beginning and duration in weeks).

Rice cultivation on a small commercial scale is being carried out at Bailey's Creek near Port Douglas in North Queensland, but the rice growing potentialities of Queensland have not been accurately surveyed at present. Much still remains to be done in soil surveying as well as all over the tropical north. The Burdekin Irrigation Scheme will eventually embrace rice-growing as the heavy soils of the flood-plain are eminently suited to rice culture. Originally it was believed water would be insufficient for rice production, but in this district some three acre-feet of rain falls during the growing period of the crop, and so little more water would be required than for other crops grown during the "dry" season; in addition the call on the water would be mainly at a time when the supply is abundant. Should rice growing be successful in the Burdekin Valley( there seems no reason

why it should not be) the project could possibly be repeated in the coastal flood-plain country of the Mitchell and other rivers which flow into the Gulf of Carpentaria. It has been calculated that one tenth of the run-off of water from the state flows from the Mitchell into the Gulf of Carpentaria. A suitable storage on the upper reaches of the Mitchell River may one day supply water to a large portion of this flood-plain for rice and pasture production. Only the Gregory River is perennial, and if a suitable dam site were found, rice production could also be developed here. Christian has suggested 130,000 acre-feet per annum as a storage limit, which, supplemented by monsoonal rainfall, might allow 30,000 acres to be sown to rice annually.

Moving from Queensland westwards into the Northern Territory, we find that potential rice-growing areas have already been mapped by the CSIRO. There are obviously many areas which Poggendorff of the CSIRO considered as suitable for rice culture. Many of these are situated in the relatively unsettled Kimberley region in the north-west of Western Australia. It may be relevant here to point out that rice is already being grown on a commercial basis at Humpty Doo near Darwin, and the results are very satisfactory. It will suffice here to say that many localities are considered to be eminently suitable and the main districts and their acreages are briefly listed below:—

1. Yeeda Plains, 25 miles from Derby. Area 30 sq. miles. The hydrological aspects of this area have not been fully studied.

2. Liveringa Plains, 60 miles from Derby. Estimated area of about 40,000 acres. In addition to natural flooding, supplementary irrigation water could be applied from near-by billabongs. A hydrological survey is necessary for furtherance of this scheme, but experimental plantings have shown that rice production is possible, and rice might be grown with improved pastures for sheep-raising.

In addition to the Gogo Plains, the Fitzroy Plains and the Lennard Valley Plains, the most widely publicized region is the Ord River Plains. The Kimberley Research Station has been located here on a dark grey-brown soil known as Cununurra Clay, which is considered suitable for successful rice production. So far rice cultivation results have been considered disappointing due to the depredations of birds, termites and a distinct lack of phosphate and nitrogen in the soil.

Summing up, it may be said that rice-growing in the tropics is mainly an engineering problem concerned with storage sites, water availability, reticulation and flood protection. The agricultural aspect of soils and general fertilizer and other requirements is still being clarified, but hopes for the future are bright, provided the demand for the product continues to exist.

*Tobacco*

This crop has had rather a chequered career and its future is still far from being clearly defined. It would appear that a much larger percentage of Australian-grown leaf must be included in manufactured tobaccos. Tobacco is a crop which can definitely play an important role in the agricultural development of Northern Australia. It has the advantage that it prefers the lighter textured soils for full colour development, and with the addition of fertilizers and controlled irrigation, it can yield high returns. This is important as irrigation schemes, in the early years of establishment at least, demand high-value crops to offset the heavy initial expenditure. Although adequate rains occur in northern Australia in summer, excesses or deficiences may cause major upsets in the physiological

processes of plant growth. There is, therefore, a need to control soil moisture, and this can only be brought about by irrigation. The North Queensland tobacco industry has been saved and expanded by small-scale irrigation works, and further extension of irrigation will be made in the Burdekin and Mareeba-Dimbulah regions; North Queensland is the sole part of Queensland producing tobacco commercially. In 1952-1953 Queensland grew 4,339 acres of tobacco, of which North Queensland produced 2,940 acres or 71%. Potentialities for tobacco growing in Queensland are enormous. Regions which are considered eminently suited to this crop are the Burdekin Delta area, which has 35,000 acres of better class tobacco soils. In a rotation of one year in four, which was originally provided to help to control the root nematode and other insect pests, the good tobacco soils may amount to 8,000 acres at least. Other areas which can definitely be utilized are the Herbert River district round Ingham, the Mareeba—Dimbulah irrigation scheme based on the 320,000 acre-feet Tinaroo Falls dam. In the Mt. Garnet area on the Upper Herbert a further 80,000 acres of suitable land is available, and the only prerequisite is ample water storage, which is a feasible proposition as satisfactory dam sites do exist.

Potentialities for tobacco growing in the Northern Territory seem to be limited to the lower reaches of the Daly River, Tipperary, and Litchfield levees where it could be grown in rotation. As there is no large-scale irrigation scheme in sight, tobacco growing would of necessity rely on natural rainfall or on small-scale pumping units. To grow tobacco on rainfall alone in Australia is a speculative and hazardous project, and does not lead to stability. Adequate advisory services are also needed in all tobacco growing areas. Possibilities for this crop are very promising but a wise and careful survey of all the necessary ingredients for success is very necessary.

*Peanut-, maize- and cotton-growing*

Peanut-growing was established in the remote areas of northern Australia by the Chinese as early as 1884. It has been heavily subsidized for many years, but the acreage cultivated has remained static. The level of husbandry practised in this industry has been low. There has been little crop rotation, soils have been seriously exhausted, and yields have steadily declined. There is considerable scope for expansion in the future, but the market for the product is a limited one. The Queensland Peanut Marketing Board has attempted to encourage increased production by offering an equal price for peanuts delivered to a rail-head in any part of the state. There is very great need for more care in seed selection, and disease control must be more rigidly exercised if there is to be any substantial expansion in the growing acreage. Baled peanut tops are excellent subsidiary feed for dairy cattle during the feed shortage of the lean and dry winter months.

Cotton growing has also been only moderately successful in the past. Successful production of this crop does not seem possible without irrigation. Mechanization is a prerequisite (for cheap human picking-labour is not available), especially if cotton is to be exported to the world markets. It has been found that the highest yields are obtained from planting in late September or early October, but this is also a season of low and unreliable rainfall. In good rainfall seasons dry-land cultivation has given good results, and in a mixed farming system timely rains can be used to grow successful cotton crops. However, mechanical picking will be the only answer to the problem of high-wage labour. A great deal depends naturally on the cost of production, especially if Australia wishes to enter the world market as an exporter. Her main aim should be to supply more of the requirements for the home market. The main scope for further cotton-growing

expansion lies mainly in the Burdekin Valley and in the Mareeba-Dimbulah irrigation area. With cotton as a rotation crop with tobacco, high yields have already been obtained in the Burdekin area, and there is no doubt this crop could fit in with tobacco and peanuts in the Kimberleys and Northern Territory, but climatic problems do exist and yields do fluctuate very considerably.

Maize is affected very seriously by adverse climatic conditions, and is not, therefore, a widely acceptable crop for tropical Australia. The most favourable area climatically is the Atherton Tableland (25,000 acres harvested each year), and in the Burdekin Valley maize finds a place on irrigated land in rotation with tobacco. A balance between dairying, maize-growing and peanut-production is achieved on the Atherton Tableland, and no expansion of maize on any considerable scale is likely here. Rather the emphasis is on maintaining present production by sound rotational systems, adequate fertilizing and effective soil erosion controls.

*Tropical Fruits and Vegetables*

Very considerable potential for the development of tropical fruit culture exists in North Queensland, provided markets are found for the products. Pineapple-growing has developed rapidly since the war ended, and the establishment of canning factories at Rockhampton, Townsville and Cairns has given a great stimulus to the growing of this fruit. However, further expansion is hampered by the overseas market position. The Canadian market for pineapple products from Australia is now closed, and Queensland is meeting severe competition in the sterling markets from both the rehabilitated Malayan industry and the rapidly expanding South African industry. Where are the best growing areas for commercial production of tropical fruits? Experts have declared that most of the rivers of Northern Territory and of North-West Western Australia would be suitable for tropical fruit production, but again the old problem faces all intending growers—markets, or rather lack of markets, plus generally high costs of production which would militate against large-scale development of tropical fruit cultures in these localities. Where there is sufficient concentration of cropping, a cannery can be built to stabilize the industry. Perhaps uranium and other mineral developments in the Northern Territory, and successful oil-drilling in the Rough Range area in Western Australia will attract a greater population and indirectly create a much greater demand for fruit and vegetables in these localities than there is at present. But this by itself would be insufficient.

*Miscellaneous Crops*

Several crops have been grown experimentally in northern Australia including sunflowers, jute, ramie, soya beans, tea, rubber, oil-palms, potatoes, pumpkins, safflower and pulses. Some success has attended sunflower-growing on the Burdekin levee soils, on the British Food Corporation's farms in the Queensland Central Highlands, and also at various research stations in the Kimberleys. Again the main obstacle is the lack of a stable and profitable market. Jute and ramie can both be grown successfully, but development on a large scale depends on the successful removal of the fibre by mechanical means. Tea of good quality has been grown at the Bureau of Tropical Agriculture at South Johnstone, and experiments in mechanical picking are taking place. This is a critical factor in the successful development of this industry. Pumpkins and English potatoes grow well on the alluvials of north Queensland, and fill in the gaps in supply experienced in southern localities. Safflower is considered as a good rotation crop for rice, having grown quite well at the Kimberley Research Station. Again the future of all these crops is bound up with world markets in relation to the high cost of

Australian labour, and they may eventually become commercially important for both overseas and internal markets. Mechanization of picking seems to be the crux of the whole problem at present.

## PASTURES

The natural grass in northern Australia is characterized by rapid growth in early summer during the wet season, followed by early flowering and ripening. From early autumn onwards (about the end of April) the feed value of this grass is very low and barely provides subsistence for the stock. The main aim of pasture research in northern Australia has been to develop improved pastures, particularly for winter feeding. The most acute deficiency is in natural legumes to provide a better diet, and also for the purpose of building up the low nitrogen content of these lateritic soils. Pastures in Northern Australia can be classified under the following headings,

1. Tropical pastures under heavy rainfall conditions.
2. Pastures for drier areas.
3. Pastures under irrigation.

It has been said that there has never been a permanent tropical pasture, and that the struggle has always been against the normal processes of rain-forest succession. Some success has been achieved in Queensland. On the elevated Atherton Tableland, paspalum, Kikuyu and white clover have been successfully used in the dairying industry. On areas at a lower elevation para, guinea and molasses grasses, in combination with the legumes centro, peuro and stylo, have given very successful results, so much so that new dairying areas earmarked for soldier settlement are now being sown with these combinations. For over five years the pastures at several research stations have been stocked at the rate of over one beef steer per acre, under a scheme of seven days grazing alternating with twenty-eight days resting. Para grass has also given consistently satisfactory results on heavy soils in northern Australia where the soil-moisture content is adequate. More space and prominence is now being given to elephant grass.

Pastures for drier areas which seem to promise well are Rhodes grass, Buffel and birdwood grasses, African Star grass and Green Panic, in conjunction with certain legumes such as Townsville lucerne and Phasemy bean. Buffel and birdwood grasses do well on the lighter soils, and Buffel has spread on to a thousand square miles of lateritic, sandy plain in the Cloncurry district, and further trials for its establishment are being carried out in lateritic 'desert' country around Jericho and Yalleroi. Enough evidence has been adduced, I believe, to show that progress, while still relatively slow, has been made in certain schemes for pasture improvement, but it is too early yet to forecast the universal success of these pasture improvements for large areas in northern Australia. Another grass, African Star grass, has been found to be particularly valuable in the black-soil zones of Central Queensland. A lucerne called Townsville has been grown very successfully, but it has been chiefly confined to the near-coastal areas of rainfall between the 30 in. and 50 in. isohyets, and prefers sandy podsolic soils. Its spread has been rapid, and since it becomes more palatable as it dries off, it provides a valuable protein supplement to natural grasses as winter approaches.

Irrigated pastures in the tropics have mainly been concerned with summer species, although recent trials on the Atherton Tableland show that phalaris, cocksfoot and white clover thrive under irrigation in that environment.

The potential of pastures in the tropics depends a good deal on the extent to which land will be used by other crops, and also on future developmental

schemes in irrigation. Lands listed as potential sugar-growing areas could all be sown to improved pastures of the tropical wet type, at least until cane-growing assignments have been allocated. In the irrigation areas, the aim is to develop large-scale irrigation pastures, and the relative prices of store-cattle and cattle fattened on irrigated pastures will determine the extent to which this industry will expand. In any case, such a project will demand high-quality young cattle, and the beef industry must shape its policy in preparing for such a demand in the future.

## CONCLUSION

It must not be concluded from the facts presented that it would be an easy task to develop the North, or that the fullest possible development will bring, in our life time at any rate, a large population. The general picture may indeed well remain as it is today—a predominantly pastoral and mining economy, with a limited amount of agriculture. The task will not be an easy one, for the facts of geography are very strong. Northern Australia is essentially a land of great plains, with mountain ranges few and low—in short a land of summer rains, high temperatures and heavy evaporation. Rainfall varies from 180 in. per year on the east coast to less than 5 in. a year in the interior; one third of the whole region has an average annual rainfall of less than 15 in., while many of the rivers flow only in summer. The good-soil areas are patchy and widely scattered, and a large area, nearly one third, is not only useless now, but is always likely to remain so, except for mining possibilities. This article has attempted to confirm the proposition that rainfall, temperature and soil are the critical factors for successful agricultural production. Rice growing in the Tropics in the North is mainly an engineering problem—storage sites, availability and reliability of rainfall, drainage and flood protection—water conservation is the key to success, provided the economic problem is successfully solved—that is, reliable and expanding markets for the products of these regions are found. But it is very significant that the most successful agricultural development in the North is found on the east coast of Queensland where a combination of heavy annual rainfall, in conjunction with numerous patches of fertile soil, has led to a fairly close settlement based on the growing of sugar and, to a less extent, of maize and tobacco. There is room for still more intensive settlement in this rich belt of country.

Therefore, northern Australia has considerable possibilities but also severe limitations. Can the problem be summed up successfully in two words, "Water conservation and markets"? Queensland has greater agricultural potential than either the Northern Territory or the Kimberleys, but these two areas cannot be allowed to stagnate, as the eyes of the world are on our "empty North". The development of this enormous area will need all the Commonwealth aid which can be given. The Government must give every inducement to encourage the settlement of farmers and graziers, and provide every amenity to attract all possible labour. Generous tax exemptions would help to encourage capital investment, and thus to some degree would ease the Government's expenditure on transport, irrigation and other developmental projects. The North may have been called "The Back Door of Australia", but that is no reason why we should not keep it in good order and use it as often as "the front door". It is quite conceivable that it may become the front door for future generations of settlers from near-by densely populated countries. The motto for Australia in the future may well be "populate or perish", and here agricultural development will have a vital role to play.

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# THE PARTITION OF BRUNEI

By K. G. TREGONNING

The Sultanate of Brunei, in North west Borneo, is today per head of population the richest state in South-East Asia, its oil output ranking it after Canada as the premier producer in the Commonwealth. This most combustible of acquisitions is fated it seems to be found among primitive peoples whose lives are radically influenced by it, and it appears inevitable that where there is oil there is trouble. Brunei is no exception.

Today there is peace on the surface in Brunei, but this great wealth has come as something of a mixed blessing. Although the liberal share-profits scheme of the oil company (Shell Brunei Ltd.) may possibly avert or at least postpone another Abadan, this new oil has awakened and made dissatisfied the intelligentsia of Brunei, and rumbles of discontent can now plainly be heard. Their agitation for a change in their position and their disgruntled attitude to their rulers may find expression in a clamour for boundary revision.

The extraordinary convolutions of Brunei on a large scale map reflect the nineteenth century partition to which it was subjected, and a logical redrawing of the territories of British Borneo, often advocated, is long overdue. But should such an attempt be resisted by its neighbours however, as appears likely, the necessary spark will be added to the oil.

The partition of Brunei began in earnest early in the nineteenth century, with the arrival in 1839 of James Brooke. Brunei had begun slipping down hill from its days of glory shortly after the visit of Pigafetta, the chronicler of Magellan. It was he who described in 1521[1] this greatest ever of Malay cities with 100,000 inhabitants, rich in wealth and proud in bearing, and its Sultans, conquerors of the Sulu archipelago, part of the Philippines, and all the northern and western rivers of Borneo as well. That had been four hundred years before, and when Brooke arrived Brunei was a squalid little heap of houses on stilts, the sultan still claiming a suzereignty over the Borneo rivers, but unable in most cases to exercise more control than that involved in appointing a relative as overlord, licensing him to plunder, and accepting what share of the proceeds he cared to pay. He for his part usually reclined in Brunei, playing the part of the absentee landlord, while his agent terrorized the inhabitants, and taxed them for what he could.

With piracy at sea, tyranny near the mouth and a confused struggle upstream, such was the situation in nearly all the river basins, and the circumstances on the Sarawak River, visited by James Brooke, only differed from the others in that it was the southernmost stream over which Brunei still claimed suzereignty.

Brooke's arrival at this struggling scene of anarchy was the most important single event in the history of modern Borneo. Granted in return for annual payments the governorship of the rebellious river, Brooke soon ceased payment of his rent, and became an independent ruler, *de facto* if not *de jure*. British Indian trade across the South China Sea to Canton was rapidly growing, and while not prepared to annex the area itself, the piratical menace posed by these

1. This description can be found most conveniently in J. Crawford's *A descriptive dictionary of the Indian islands and adjacent countries* (London, 1856), pp. 70-2.

uncontrolled rivers was severe enough for the British government to acquiesce in the settlement of Brooke, and to permit, even to encourage, his steady encroachment northwards towards Brunei.

In 1846 Palmerston acquired for Britain from Brunei the uninhabitated offshore island of Labuan, hoping it would act, as did Hong Kong, Singapore and Penang, as a centre convenient both for the navy and for trade. It failed in both respects, and remained, to the delight of Clifford, Conrad and Maugham, a stagnant tropical backwater. But Her Majesty's representative there was able constantly to inform the home officials that the Sultan of Brunei was capable of controlling neither his court, his relatives nor his rivers, and that the only cheap

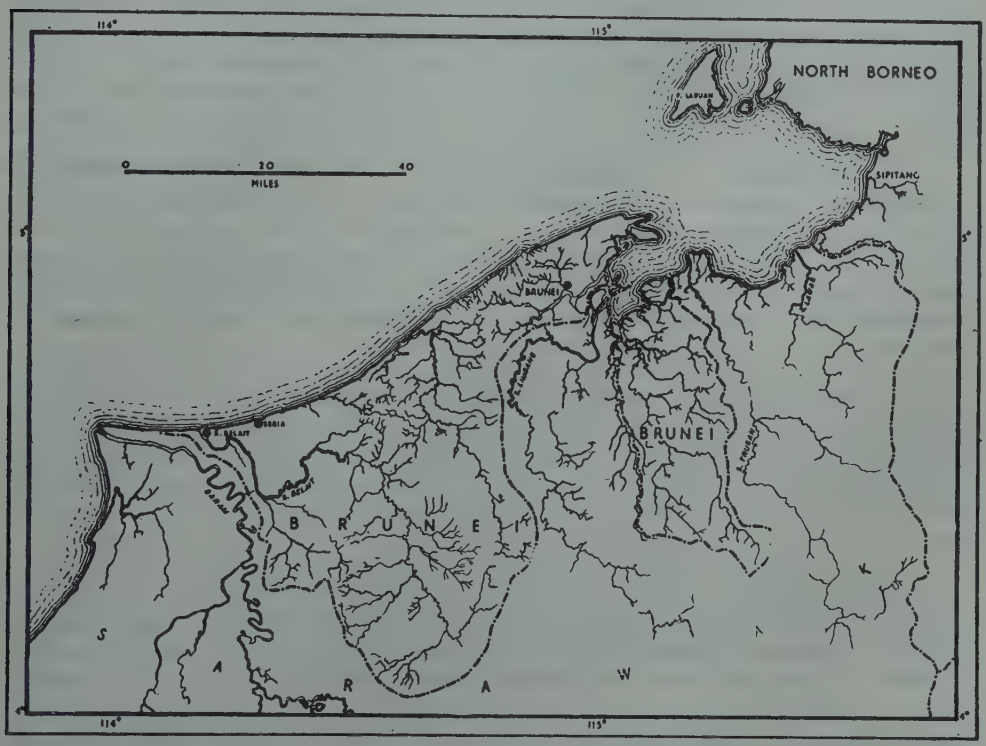


Fig. 1. Location map of Brunei.

substitute to the threat of piracy and the dimunition of trade this implied was to sanction, under the 1847 treaty with Brunei, his cessions of southern territory to Brooke.[1] Thus the precedent was established.

It was maintained in 1881 when a new character appeared on the Brunei scene, the British North Borneo Chartered Company. In the Malay Peninsula by this time, and in Africa and elsewhere where British penetration was proceding, the method generally involved a preservation of the indigenous political framework. In Malaya Residents were buttressing the Sultans, and maintaining the boundaries of their states. But in Malaya Britain was vitally concerned, there were interests there that needed official watching. Borneo was on the flank, not directly in the

1. For a detailed account of these cessions see G. Irwin, *Nineteenth century Borneo* (The Hague, 1955).

path, of the China trade, and a slackening of interest was evident. Given that Brunei could not control these rivers, that law and order did not exist, both of which were obvious, and that foreign intervention there in 1881 was as undesirable as piracy in 1841, it was adequate, and it was certainly cheaper, to permit annexation, rather than to accept direct responsibility. So the North Borneo Chartered Company was permitted to acquire from Brunei a territory in the north as large as Ireland, and the troubles really began.

James Brooke, before his death in 1867, had passed on to his nephew who succeeded him, Charles Brooke, his outlook and his policy. His outlook was that of a game warden, anxious to preserve his animals. His policy was to make all of west and north Borneo, all of ancient Brunei, a safe national park for his Dyaks. This presupposed the complete elimination of the Sultanate,[1] and when in 1881 the Chartered Company appeared, another dog on the other side of the same bone, tension immediately increased, and the rate of annexation speeded up.

By 1881 Sarawak had eliminated piracy and had established law, order and a modicum of government over a considerable part of the anarchy-ridden territories of Brunei. Cessions in 1846, 1853 and 1861 had brought it as far north as the Bintulu River. Now with the presence of the chartered company as a spur Charles Brooke took another bound forward and acquired in 1882 the mighty Baram River. And again the British government sanctioned this transfer of territory.

To the north of the now compressed little state, verging on complete ruin and in the throes of utter dissolution and poverty, the chartered company began a double task, of acquiring the various independent rivers left imbedded in the Brunei cession to it, which were owned by landlords in Brunei, and which by reason of their lawlessness were an irritant in the body of North Borneo, and also at the same time of moving south.

This Brooke frantically opposed. In 1878, at the first arrival of the newcomers, he had steamed north and urged the natives to resist,[2] and when in 1884 the company acquired a large triangle of territory known as the Padas-Klias peninsula, an area of nearly four thousand square miles, Brooke urged the Foreign Office in London not to recognize the cession, and sent in a *pengeran* from Sarawak to sow unrest. He was forcibly expelled, but another agent, Pengeran Raup, was able the following year to organize an intrigue that brought about the death of two Europeans when they entered the Kawang River, and nearly precipitated further bloodshed.[3]

Rajah Brooke not merely endeavoured to discredit his northern rival, but made efforts as well to thwart any further southern move. Hot for the complete extinction of Brunei he came to the *north* of it in 1884, shortly after the cession of the Padas-Klias Peninsula, and acquired from its usual absenteee landlord the solitary Trusan River. By this move he bisected Brunei territory, barred the

1. Baring-Gould and Bampfylde, *A history of Sarawak under its two white rajahs* (London, 1909), p. 337.
2. *PRO., Foreign Office, Series 12/54.* Rajah Brooke to Governor, Labuan, April 6, 1878.
3. *British North Borneo Chartered Company records.* Governor to Court of Directors, March 30, 1885 (enclosing Brooke to Governor, March 8, 1885).

southern move of the company, and forced Brunei into the powerful encircling embrace of Sarawak.[1]

Between Brunei town and the Trusan was only the Limbang River, with oppressed and revolting natives upstream and exacting, uncontrolled nobles near the mouth. The governor of Labuan already had steamed up it and on his own initiative and with great difficulty quelled the warfare and disorder there. Brooke now set out to make it his, and for once the sultan objected. The struggle for the Limbang, coupled to international considerations, precipitated the intervention at last of Britain.[2]

By the 1880's the great European expansion was under way. Africa and Asia were being divided, economically or politically, between the powers, and Borneo, remote though it was, could not remain aloof. In particular, although politicans in London might prevaricate, the permanent officials at the Colonial and Foreign Offices were apprehensive of the new colonial ambitions of Bismark. To quell the ceaseless stream of vituperative correspondence that reached them from the wrangling parties in Borneo, and to guard against German intervention at Brunei, London decided a Protectorate would have to be established over the whole area.[3]

Territorially it was decided by Britain that North Boreno should be permitted to acquire all the Brunei territory between its southern boundary and the Trusan, the bar Brooke had flung in its path north of Brunei, while Brooke would be permitted to acquire all the Brunei territory south of the Trusan until his northern boundary on the Baram was reached, excluding only the small Brunei stream itself. It was suggested that Sir Francis Weld, Governor of the Straits Settlements, be sent to supervise "the delicate negotiations" that would be necessary.

Weld found the Sultan determined to preserve the little that remained. He insisted on two concessions, the retention within his state of the mighty Limbang, which was to his capital as the Nile is to Alexandria, and the appointment of a British Resident. Weld supported him on both counts, but in London the Foreign Office agreed with the Colonial Office that Brunei was too impoverished to pay for a Resident, (and no one dared approach the Treasury), and too inefficient to police the Limbang.[4] With the Sultan's signature to the 1888 Protectorate agreement obtained, the British withdrew again, having barred the intervention of any other power into a rump of territory it felt unable to govern itself.

A similar agreement was signed by the Chartered Company well pleased by the additional prestige thus gained, and by Sarawak, surrendering the control of their foreign affairs to Britain, and the latter being called on to state that any future question as to the right of succession would be referred to Britain for decision.

Brooke bided his time, then in March 1890 steamed up the Limbang and annexed it. The Sultan refused to discuss compensation, declined repeatedly, although all Brunei was impoverished, to accept the S$6,000 Sarawak had decided was a fair annual rental, and wrote persistently to the Foreign Office asking for his river. In 1895 he was informed that the question was closed. Sarawak was

1. *PRO., FO. 12/76.* Memorandum, March 30, 1887.
2. *Granville Papers, GD. 29/336.* Consul-General Treacher to Lord Granville, Oct. 28, 1884.
3. *PRO., FO. 12/76.* Memorandum by Perm. Under-Secretary Pauncefote, April 28, 1887 [This memorandum clearly shows that international fears were secondary in relation to the internal arguing for rivers in Borneo].
4. *PRO., FO. 12/77.* Sir R. Herbert, Perm. Under-Secretary, Colonial Office to Sir J. Pauncefote, Foreign Office, December 10, 1887.

confirmed in possession, divorced though the river was from the remainder of the the state.[1] It has remained a white elephant ever since.

The Limbang problem was revived in 1941 when the advisor to the last of the white rajahs, G. T. MacBryan, a Muslim, negotiated with the descendants of the Limbang chiefs. Convinced, it would appear, that the Limbang seizure was an unworthy page of Sarawak history, he proposed a financial redress of some $20,000, and $1,000 annually. This was accepted by incredulous Brunei, but on news of the transaction reaching the ears of the High Commissioner for the Straits Settlements, the agent through whom all Borneo affairs had to pass, it was cancelled immediately. Sarawak still retains this territory on the far side of Brunei, and still hungers, so it is believed in Brunei, for the rest.

North Borneo waited some time before acquiring the Brunei territory assigned to it , its first steps being the purchase in 1896 of the numerous Brunei-controlled rivers left on its western flank far from the centre of controversy. When armed bands from two of them, Inanam and Mengkabong, in support of Mat Saleh, burnt and sacked to the ground its chief west-coast settlement, P. Gaya, there were hurried negotiations with Brunei, followed by their swift transfer. But the Brunei-controlled rivers between North Borneo and Sarawak were not acquired until the next century. Lawas, the chief of them, was a renowned slave-market as late as 1902, and although it was ceded to the company that year by a Sultan grateful even for the $600 offered, the Pengeran in charge proved so antipathetic to European rule that it was relinquished to Sarawak in 1905.

With the sale of the Brunei Bay rivers the Sultanate, partitioned and prostrate, apparently was near the end. In no way whatever had the establishment of a British Protectorate alleviated the misery or improved the condition of what had become not the Venice of the East but the Vienna. Since 1888 hundreds of families had left to escape the unbearable conditions of tyranny and lawlessness that prevailed, and finally Britain decided that this state of affairs must be abolished.

In 1900 instructions were given that on the death of the Sultan, if not earlier, the existing administration should be brought to an end and the country partitioned completely.[2] While North Borneo, led by an able Malay-States administrator (Birch), protested vehemently at this policy, Brooke endeavoured to secure its complete transfer to him. The Sultan was offered monthly a salary of $1,000 in return for his few remaining sovereign rights.[3] The end was in sight.

Then came reprieve, and with it, new life. In a dramatic volte-face Britain changed its policy from absorbtion to protection, and has maintained that attitude ever since. The reasons for the change from the outlook first accepted in 1839 are not known, for the relevent documents are still closed to the researcher. And although cynics may point out that the appointment of the first British Resident in 1905, charged with maintaining the State, was preceded in 1904 by the first discovery of oil in Brunei, it is not known whether the nearness of these two occurrences is merely a coincidence or not.[4] Nevertheless, the first free flow of oil and the arrival of the first British Resident combined to save the state.

1. *PRO., FO. 12/106.* Memorandum: "There is no doubt that Brooke acted wrongly in occupying the Limbang without the previous sanction of H.M. Govt, but in view of the fact that the Sultan is quite incapable of ruling the district, and that most of the chiefs have declared in favour of the Rajah, it was decided to confirm the latter in possession."
2. *PRO., FO. 12/113.* Foreign Office to High Commissioner for Borneo Territories, April 27, 1902.
3. *British North Borneo Company records.* Governor to High Commissioner, October 18,, 1902.
4. H.R. Hughes-Hallett, "History of Brunei", *Journal of the Malayan Branch of the Royal Asiatic Society,* vol. *xviii,* pt. 2 (Singapore, 1940), p. 41.

But today a new factor has appeared which must be considered. For so long the ignored object of partition, Brunei with its new strength is able to speak for itself. It seems desirable that obvious bones of contention should be quietly removed from the arena, and in this respect a rationalization of the incredible political boundaries needs to be considered. The Brunei Bay area, with Labuan, could well become again the political and economic unit it was before, giving increased scope to the development capabilities of Brunei's great wealth. And content though the remainder of British Borneo is to remain in the horse-and-buggy days, some further merger or amalgamation between these territories seems highly desirable, if the territories are not to face the remainder of the twentieth century in their old-fashioned nineteeth-century clothes.

# PROVISIONAL AGRICULTURAL REGIONS OF GHANA

By H. P. WHITE

One of the chief difficulties encountered in the making of regional studies in West Africa is the satisfactory drawing of regional boundaries. The field worker is soon aware that certain areas have a distinctive physical environment and an economic and social adjustment to it which is also also distinctive. They are, in fact, regional entities. But each such region has a frustrating habit of merging gradually and without any marked break into the next region, a result of climate and vegetation being the principal environmental influences.

While there are some notable and welcome exceptions, there are few opportunities of drawing clear-cut boundaries on a physiographic basis, for most of West Africa is made up of almost featureless plateaux. Changes of soil type may also occasionally have a sufficiently marked effect on the human response for the boundary to be taken as regional one. But on the whole they are not fundamental to the human geography as are climate and vegetation. On the human side, tribal distribution is often complex and again there are seldom clear-cut boundaries between tribal and other ethnic groups. Political boundaries, created arbitrarily by European powers in the latter part of the nineteenth century, bear even less relation to the facts of geography than they do in other parts of the world. Finally, statistical data, which have often been used to good effect in determining regional boundaries in areas lacking in clear topographic divisions, are almost completely lacking. It is scarcely surprising that few attempts have been made to delimit the geographical regions of West Africa. As a first attempt, a provisional division of Ghana, a small but nevertheless important part of West Africa, is offered here.

A division into agricultural regions has some validity as a basis for a division into geographical regions, since agriculture absorbs most of the economic effort in Ghana, as in West Africa as a whole. No figures are available for subsistance production, which forms the major part, but as a result of the 1948 census,[1] we do know that of the 1·3 million males over 15 years, 150,020 or 11·5 per cent were described as being occupied in "cocoa cultivation." In addition, 797,025 or 60·9 per cent were described as "remainder." The overwhelming majority of these would be farmers not producing cocoa. It must also be remembered that, on the whole, the cocoa farmers grow their own food. The weight of the evidence[2] is that the cocoa areas are largely self-supporting as far as food is concerned and in addition, sufficient food is produced in the country to feed the half-million people in towns of over 5,000 as well as the growing numbers of rural dwellers who do not grow their own food.

As to the external exchange sector of the economy, in this agriculture is also of vital importance. In 1954 £86·1 million or 75·5 per cent of the exports were of cocoa or other agricultural products. This may be compared with the public revenue in that year of £49·9 million.

1. Gold Coast government: census of population, 1948 (London, 1950).
2. See, among others: I. H. Beckett, "Akokoaso", *London School of Economics and Political Science monograph on social anthropology* (London, 1944), p. 21 and R. W. Steel, "Some geographical problems of land use in British West Africa," *Proceedings of the Institute of British Geographers* (Oxford, 1948), pp. 29-42—but note that the latter author has doubts about this trend continuing.

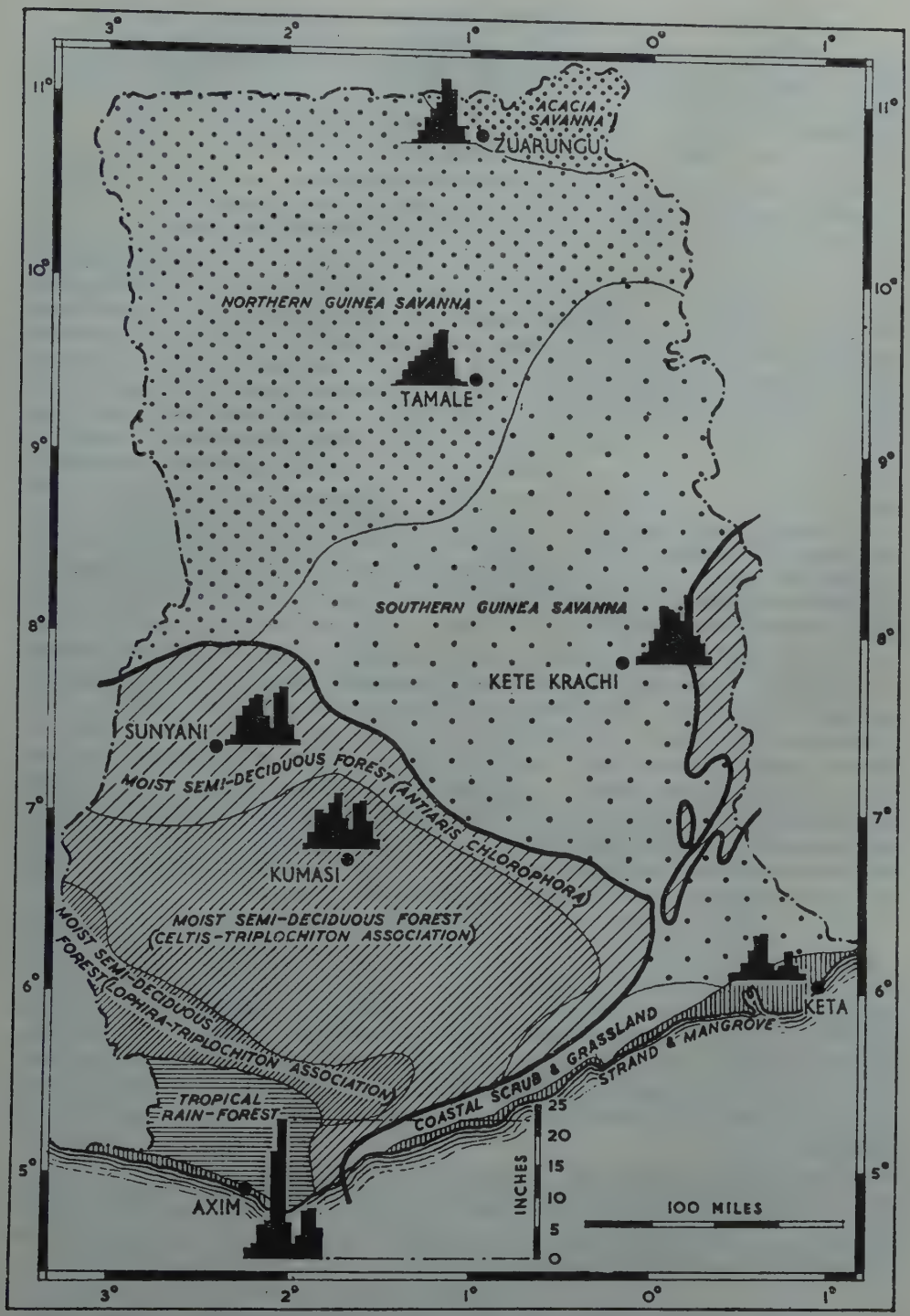


Fig. 1. Ghana: (i) rainfall at selected stations and (ii) vegetation zones.

As is general throughout tropical Africa, the most important single environmental influence on agriculture is the availability of water. Irrigation, apart from the growing of rice in swamps naturally flooded during the rains, is unknown to the farmers of Ghana, so agriculture is wholly dependent on the amount and distribution of rainfall. There is thus a close, though not identical, correlation between rainfall regime, natural vegetation and farming types.

Fig. 1 has been prepared to show the relation between rainfall and vegetation. It will be seen that, as a general rule, precipitation declines in amount northward and eastward and that there is a shorter period of rains to the north.

The vegetation zones are based on those of Taylor.[1] They show that the country is divisible into three major regions: (1) The forest, (2) The coastal savannas, and (3) The northern savannas. Any geographical division of Ghana must take these divisions into account as the environment in each is so different. They are, however, drawn on a purely botanical basis and so do not coincide exactly with any scheme of division into geographical regions. For instance, it will be seen that a portion of the coastal region to the south-east of the forest is botanically part of the northern savannas. Economically and culturally, however, *all* the area south and east of the forest zone should be considered part of the major region we can call the Coastal Belt. Nor can the sub-divisions of the three major zones be taken as a basis for division into geographical regions, for considerable differences emerge as will be seen later. But any such division into geographical regions, and especially into agricultural regions, must bear some overall relationship to the vegetation zones, since they are a reflection, for the most part, of water availability.

As far as I am aware, this is the first attempt at mapping such a division, and therefore, especially in the absence of statistical data, much of it must be regarded as tentative, and should therefore be treated with caution. The Department of Agriculture, for instance, recognizes, but does not delimit, a "coastal thicket" region, which transcends the boundaries of the coastal belt and forest. In this scheme, however, the regional boundary is taken as the southern limit of the closed-forest zone, on a basis of similarity of farming methods, which separates clearly forest from coastal belt. Where in this division a boundary can be drawn with some certainty, a continuous line has been used. Where delimintation is in doubt a pecked line has been employed.

The broad framework of any such division still remains the vegetation zones. But for further sub-division and for any adjustment necessary in the boundaries of the major regions adequate field-work is, in the absence of statistical data, vitally important. This is regretably incomplete in the present case, for Ghana is relatively large and roads are few. It has, therefore, been perforce supplemented by interviews and collection of second-hand information. In some cases, however, boundaries are clear-cut along a prominent physical feature, vegetational contrast or cultural boundary. The cocoa belt alone can be delimited statistically.

The principal division into agricultural regions is therefore threefold into Forest, Coastal Belt and Northern Savannas. Of these the Forest is the most important, for not only is all the cocoa grown within it, but the larger part of the foodstuffs as well.

1. C. J. Taylor, "The vegetation zones of the Gold Coast," *Forestry department bulletin no. 4* (Accra, 1952).

## 1. THE FOREST

This is usually regarded as being the area in which closed forest would regenerate naturally under the present climatic and edaphic conditions. Under the existing biotic conditions, however, very little of the zone, probably no more than a third is actually under closed forest, and much of this is disappearing.[1] The rest has been cleared for farm-land and is either in field crops, permanent crops such as cocoa, or is in fallow. In some places, mainly on the edges of the Forest Zone or around towns, all trees have disappeared and fallows are invaded almost solely by grasses or herbaceous plants. Seven sub-regions can be distinguished, each with its own characteristics which are sufficiently marked for it to be regarded as a regional unity from the agricultural point of view.

(i) *The Main Cocoa Belt* is the area dominated by cocoa, though it must be remembered that sufficient food crops are produced for the area to be nearly, if not quite, self-supporting. In addition, in the newer and expanding areas, since the young cocoa is raised under nurse crops of cocyam (*Xanthosoma sagittifolium*) and plantain, there is a large surplus of food. In western Ashanti this is available for export as there are adequate roads and a large market near by, Kumasi (population 70,705 in 1948).

The area has been delimited statistically on a basis of figures for cocoa-buying provided by the Ghana Cocoa Marketing Board. These figures have one drawback, albeit of a temporary nature. They do not give full weight to the expanding fringe in western Ashanti where there is much young cocoa not yet in full bearing. In this area, therefore, the boundary has been adjusted on the basis of the field-sheets of the cocoa survey carried out by the Department of Agriculture. Delimitation will be more accurate when the completed survey becomes available.

(ii) *The Togo Cocoa Belt* is an outlier of the foregoing with similar charateristics and delimited in a similar manner. Easy export of foodstuffs from the nurse crops of the newer areas is not, however, possible because of inadequate roads and distance from markets.

(iii) *The South-Eastern Food-Crop Belt* occupies the drier south-eatern fringes of the Forest. The system of food cropping does not greatly differ from those of the foregoing regions, except that more maize is grown, the consequence of more light reaching the ground with the widespread disappearance of tree cover. But, while some cocoa is produced, it no longer dominates the economy. Indeed, as a result of the devastating attacks of swollen shoot the crop is rapidly disappearing from the south-eastern part of the region.[2]

In the past, however, cocoa was important and so living standards are high and settlement close (over 200 per sq. mile in some parts). There are no economic minerals and forest resources are rapidly vanishing. The area is therefore distinguished by its dependence on food cropping for cash sale. The growth of this activity has been aided by the growth of the coastal towns, with an estimated population of some 300,000, in a savanna region of very low productivity under existing economic conditions.

The northern boundary is that of the cocoa belt, while the southern can be delimited with some accuracy as the edge of the Forest according to Taylor, and

1. See contribution by C.F. Charter to discussion of a paper by A.E. Moss, "Age of Gold Coast cocoa trees and long term production prospects," *Proceedings of the Cocoa Conference* (1953). See also Appendix III of the *Proceedings.*
2. J. D. Broatch, "Progress of the Gold Coast swollen shoot campaign," *Proceedings of the Cocoa Conference* (London, 1953).

as the Akwapim scarp in the southeast. Its western limit is, however, uncertain. But a growing body of information concerning food exports from this region is being built up[1] and in the near future it may well be possible to delimit the zone on this basis.

(iv) *Krobo.* This region is essentially similar, but a regional unity is imparted by its culture. It is an area of a land tenure system unique in Ghana, the *huza* system.[2]

The previous home of the Krobo lies to the south. It had become over-populated and emigrants bought land to the north. To do so they pooled their capital and the land thus purchased was divided into strips running uphill back from a stream. The frontage of each plot is in proportion to the share of capital subscribed, but no similar account is taken of depth. The land was cleared back as required and planted with cocoa and foodstuffs. Since the former has never done remarkably well, the region has necessarily, because of the cash investment in the land, developed into a producer of food crops for cash sale.

Delimitation is easy, the region being taken to include the area of "shoe-string" settlement associated with the *huza* system and clearly distinguishable on topographic maps.

(v) *The Togo Hills and Plains* lie to the south of the Togo Cocoa Belt. Relict forest covers the hills and, as a result of annual burning, savanna bush the plains. Water and soil conditions render many of the lowland areas unsuitable for cultivation, which is therefore confined to the hills, their immediate environs and to the gallery woodlands along the rivers. Though there are thus two contrasting types of landscape, they are too inextricably mixed to be separated into two regions. Grains are the most important group of crops and hill rice is charateristic of the area.

Delimitation is made on a basis of morphology. The region is taken to include the ridges and dissected plateaux of the Togo-Atacora Mountains, together with the intervening plains.

(vi) *The Mampong-Kwahu Plateau.* Again this peripheral area of the Forest is limited to food cropping, this time as it is exposed to the desiccating *harmattan* which comes from the north-east from December to February. Physically the region is clearly defined, by the River Afram and the Ejura Scarp to the north-east and to the south-west by the precipitous plateau edge where the Voltaian sandstone gives way to the older granites and gneisses to the south. It is only where communications allow, in the neighbourhood of Mampong, Mpraeso and Begoro, that cash cropping, chiefly of maize, is possible, but the economy is generally typical of the Forest as a whole.

(viii) *The Western Forest.* This achieves a regional unity through a number of influences combining to make this a largely negative area from the agricultural point of view. The wet climate (Fig. 1) promotes a very dense forest growth, which increases the difficulty of clearing and cultivation by present methods. It is unsuited to cocoa as there is no real dry season to check fungoid diseases. Apart from settlement along the western railway from Takoradi and along the coast, population is very sparse, less than 25 per sq. mile generally, and often much

1. H. P. White, "The Movement of Staple Foods in the Gold Coast"—*Economic Geography,* vol. 32 (1956), pp. 115-25.
2. For a full account of the *huza* system see:— M. J. Field, "The Agricultural System of Manya Krobo," *Africa,* vol. 14 (1943/4), pp. 54-65.

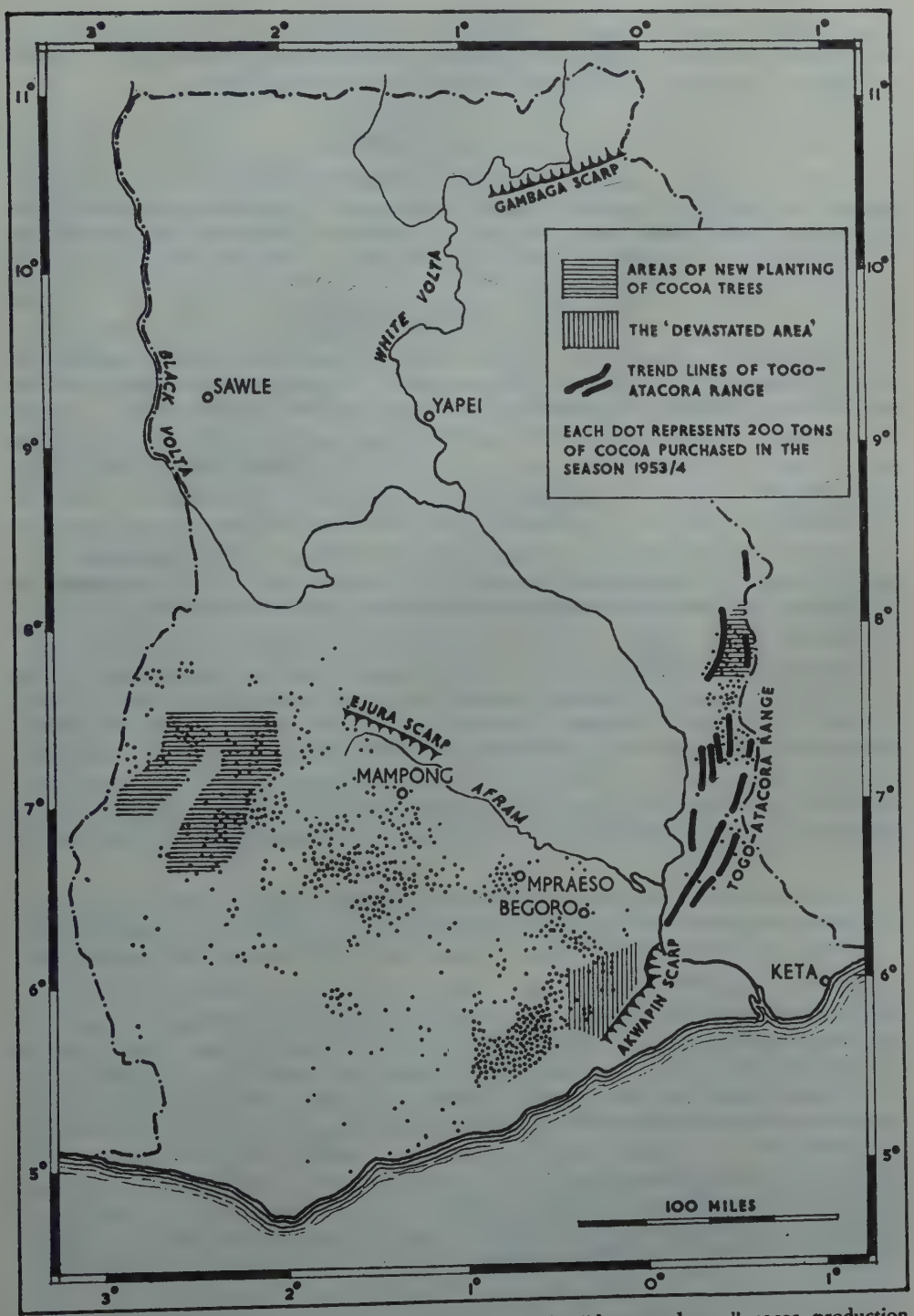


Fig. 2. Some aspects of cocoa-planting in Ghana. In the "devastated area" cocoa production has virtually ceased as a result of swollen-shoot infestation.

less. Forest crops are grown, but maize is unimportant and swamp rice is widespread. The area is clearly a regional entity, but in the absence of physical or cultural features or of statistical data, delimitation is difficult.

## 2. THE COASTAL BELT

This zone is characterized by its low rainfall, the intensity of the longer dry season and the short, unreliable second rainy season. Accra has an annual mean of 28·9 in., an October mean, the peak of the second rains, of 2·65 in. and an absolute range in 30 years of from 10·84 to 45·28 in. This climate, together with certain edaphic and biotic factors, results in a savanna vegetation, with thicket where conditions are wetter, that is along the forest edge, and with extensive areas of open grassland. The choice of crops is drastically reduced. Only cassava and pulses such as pigeon peas (*Cajanus cajan*) and tiger nuts (*Cyperus esculentus*) can be grown over the whole belt, but maize becomes locally important where conditions are slightly wetter and soil texture rather better than usual.

The belt is thus, is general, poor in agricultural resources. On the other hand, because it is the zone of contact with the outside world, urban development has proceeded further than in any other of the country. The region is thus one of deficiency as regards food and other agricultural products.

Four sub-divisions can be distinguished, to which a fifth, climatically part of the Forest, but economically similar to the rest of the coast, can be added. Delimitation is made easier because of the narrow width of the belt.

(i) *The Southern Coast* is a narrow zone between the Forest and the sea, never more than ten miles wide and often less. There are scattered patches of cassava and maize cultivation with a small production of such vegetables as tomatoes, okra (*Hibiscus esculentus*) and pepper (*Capsicum* spp.) round the towns. As everywhere along the coast, cultivation is often a part time occupation combined with fishing.

(ii) *The Accra Plains.* This triangular area is bounded by the Akwapim scarp, the Volta River and the coast. It is a grassland with scattered clumps of trees and bush. Except at the foot of the scarp, maize cannot be grown and cassava is the only staple crop.

While most of the plains are underlain by acid gneiss, basic gneiss outcrops in the central part. This latter forms heavy montmorillanite clays impossible to cultivate under present conditions. Along the Volta and the sea coast fishing is combined with agriculture.[1]

(iii) *The Trans-Volta Plains.* These do not differ greatly from the previous region, except that water is slightly less deficient. There are also extensive areas of red soils, an extension of the "terre de barre" of French Togoland which are of a better texture for plant growth. Here, therefore, on these soils is extensive cultivation of maize and cassava; elsewhere cultivation is scattered. The outcrops of basic gneiss are again negative areas. The long, narrow sand-dune coast separating the Keta lagoon from the sea is a special area. On it lives a very dense population engaged, among other activities, in the production of copra from the coconut palms which cover the dunes, and in the intensive onion cultivation peculiar to the Keta area, which carried out on the inner fringe of the dunes.

1. For further sub-divisions of the Accra plains see H. P. White, "Environment and land utilization on the Accra plains," *Journal of the West African Science Association,* vol. 1 (1954/5), pp. 46-62.

The north western boundary of the region is clearly the line of the Togo-Atacora Range which continues the line of the Akwapim.

(iv) *The Dzodze Oil-Palm Belt.* Along the frontier is to be found a northward extension of the red soils. With the increased rainfall, though no longer forested, the plains are thickly covered with oil palms, which give the region its distinctive character. Maize and cassava are also extensively grown.

(v) *The Nzima Coast.* Although part of the Forest, this small region is part of the coastal belt as far as its economy is concerned. The coastal dunes are closely planted with coconuts, but otherwise there is little agriculture.

### 3. THE NORTHERN SAVANNAS

Here for the most part there is a single dry season and its length and intensity gradually increase in a north-easterly direction. This results in the choice of crops differing in the north from that along the Forest border. Eight agricultural regions have been distinguished, but in most cases their boundaries have not been accurately delimited.

(i) *The Afram Plains.* Between the gallery forest of the Volta and the Afram is a large southward extension of the Guinea Savanna, a close savanna woodland. It is a negative region, the result of extensive areas of very poor silty and clayey soils, stretches of lateritic iron-pan, flooding in the wet season and water shortage in the dry. It is almost uninhabited and roadless. The main activity has hitherto been hunting but yams are now being grown where lorry tracks can be pioneered.

(ii) *The North Ashanti Yam Belt.* This broad belt of country extends from the Volta right across to the Ivory Coast. It is covered for the most part with thick savanna woodland. As on most of the Northern Savannas, the basis of agriculture is the production of yams and grain. A typical rotation is yam, maize or guinea corn (sorghum), hill rice and cassava, after which the land reverts to fallow. What distinguishes this area is that the yams are grown for sale to satisfy the great demand in the large towns to the south. Cash cropping of yams is extending as roads are developed.

(iii) *The Eastern Districts.* Cultivation in this region is very similar to that in the foregoing. Commercial yam farming is, however, much more restricted and farming is mainly for subsistance.

(iv) *The Tamale Region.* The distinctive character of this region is imparted by the greater density of population around the town of Tamale (15,000), the only large town on the Northern Savannas. This has led to a greater intensification of land use. The ample fallow periods common in most of the yam-grain areas have been reduced, especially where the cultivation is near the town or along the roads radiating from it. Fertility has been reduced and there is some danger of soil exhaustion and erosion.

(v) *Gonja* is distinguished by its very sparse population. There was a density of only 4 persons per sq. mile in the Western Gonja Census District in 1948. There are but seven villages along the 90 miles of road from Yapei to Sawle. Apart from a ring about two or three miles in diameter round each village, in which some cultivation is found, there are large areas which are never cultivated and where the only interference by man is the regular burning for grazing and hunting.

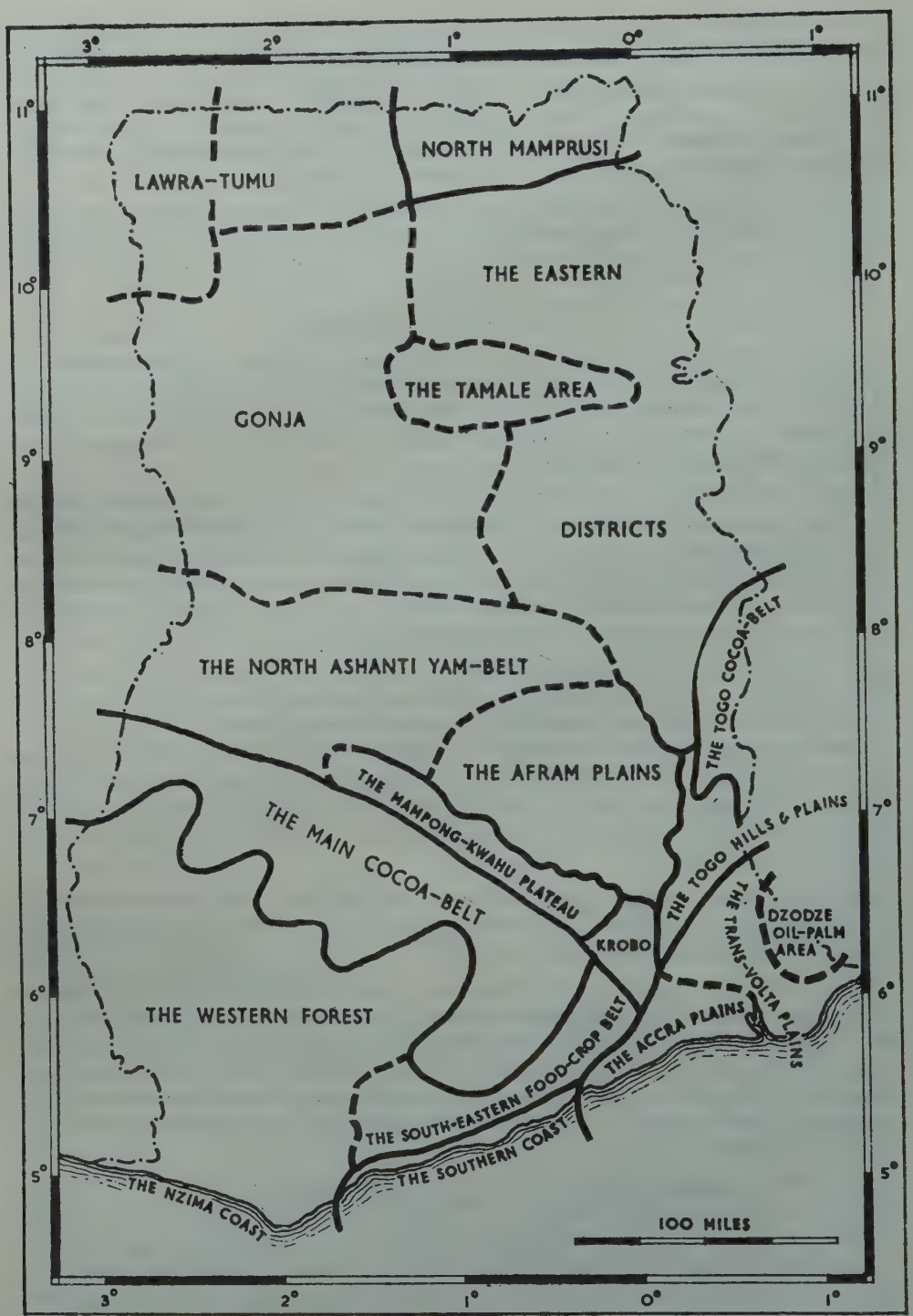


Fig. 3. Ghana: provisional agricultural regions. Ill-defined boundaries are represented by pecked lines.

(vi) *North Mamprusi.* This is one of the most distinctive regions in Ghana. It is an area of very dense population, by African standards, with over 200 persons per sq. mile in many parts. The dispersed settlement pattern is unusual in Ghana and it also has a distinctive economy.

Pressure of population is such that there is insufficient land for the normal "bush-fallowing" method of restoring fertility to cropped land. Instead "compound-farms", that is the cropped lands immediately around the compounds, assume a greater importance, while the "bush-farms" on which normal cultivation methods are practised, have but minor importance. The compound-farms are cultivated on a semi-permanent basis and fertility is partially restored by the addition, in no systematic manner, of night soil, household waste and the droppings of poultry and goats, and by an occasional year's fallow.

Yams are virtually unknown and agriculture is based on grain and pulses. The chief grain is millet and guinea corn is also grown. Rice is grown during the wet season in swampy hollows and tobacco as a dry season crop in the river beds.

North Mamprusi is bounded to the south by the prominent Gambaga scarp, which is also the boundary between the granite soils to the north and the sandstone soils to the south. To the east and north is the international boundary, which has some meaning here since population densities immediately across it are significantly lower although the environment is similar. To the west is the negative area of the Sisili Valley, cleared of population by exhausted soils and parasitic diseases for which it has gained an evil reputation.

(vii) *Tumu* Lies beyond the Sisili River. Settlement is in the form of large compact villages, each surrounded by a belt of exausted land, while beyond lies the savanna woodland from which farms have been carved. The yam-grain economy already mentioned is also found here.

(viii) *The North West.* From Wa northward to the frontier is a closely settled and extensively farmed region. Settlement is in the form of small villages, but the agricultural economy is very similar to that of North Mamprusi. Shortage is not so acute as in that area however and there are some stretches almost without cultivation.

It will be noted that no account of livestock has been taken in delimiting these regions. In 1951 there were but 395,160 head of cattle according to the census carried out by the Department of Animal Health. These were confined to the relatively tsetse-free areas of the south-eastern savanna lands and those of the north-west and north-east. They are in no sense integrated into the general farming system (apart from those of the few mixed farmers established in North Mamprusi by the encouragement of the Department of Agriculture). Though some are sold they are mainly kept for reasons of social prestige. On the other hand, small livestock, goats and poultry mainly are kept ubiquitously, almost every household having some.

This provisional division of Ghana into agricultural regions has been made only as a starting point for further work. It is offered here, for reasons outlined, as a starting point for the regional study of Ghana. Interest in tropical geography is growing and it has been claimed that regional geography is the central objective of the geographical discipline.[1]

1. S. W. Wooldridge, "Reflections on regional geography in teaching and research," *Proceedings of the Institute of British Geographers* (Oxford, 1950), pp. 1-11.

# EROSION AND SEDIMENTATION FROM AERIAL PHOTOGRAPHS

## A MICRO-STUDY FROM NIGERIA

By JEAN CARTER

The following text is a commentary on Figs. 2 and 3, which were compiled from aerial photographs. The area concerned is south-west of Enugu in Eastern Region, Nigeria, and the photographic references are as follows: Survey Department, Lagos: Enugu escarpment, scale 1:5000, AE/S/373. Fig. 2: 92240-92247 of 7 Jan., 1955. Fig. 3: 51901-51913 of 31 March, 1955.

### THE GEOLOGICAL AND HUMAN SETTING

The area shown on Figs. 2 and 3 forms part of the western limb of an anticline with its major axis from north to south. Subaerial denudation has exposed the core of less resistant mid-Cretaceous beds which underlie the low Enugu Plains; most of Fig. 3 shows these plains, lying at a height of about 400 ft. at the bridge over the river. Fig. 2, where hills rise to 1400 ft. in the west, covers part of the well-marked, east facing escarpment of Upper Cretaceous rocks which bounds the Enugu plains on the west.

The top of the escarpment and the first few hundred feet of the scarp face are composed of False-bedded Sandstones (see cross-section). These rocks are coarse-grained, very porous, and result in a normal landscape of long, rolling ridges, separated by dry depressions, all capped by a decomposition layer of Red Earth which may be up to 60 ft. deep. White Sandstones and Lower Coal Measures form an intermediate zone in the lower part of the scarp. The rock here is very varied, with bands of shale and limestone in the sandstones, but is on the whole finer-grained and compact, giving rise to a landscape of steep-sided hills and spurs, with at least one major and several minor resistant bands standing out as small scarps. The lowest land east of the scarp is underlain by Enugu Shales, which are less resistant to erosion and form low plateaux.

There is no surface drainage on the False-bedded Sandstones, but springs emerge at the junction of these beds and the impervious White Sandstones. Below this junction there is a normal pattern of surface drainage and the streams flow east to the Aboine River, part of the Cross River system. The area covered by the two maps traces the course of one of the tributaries of the Aboine River, the Nyaba. Its headwaters rise in the scarp zone and the river descends in a deeply cut, restricted channel through the White Sandstones and Lower Coal Measures, and emerges on the Enugu plains in a broad, heavily silted valley. The western edge of the map shows the upper surface of the escarpment; the descent of the scarp begins about one mile to the east, and the exit to the Enugu Plains approximately at the confluence of the major tributary from the south-west. Fig. 2 therefore, is the scarp course, and Fig. 3 the lower spurs and plains course of the River Nyaba.

The rolling sand-lands at the top of the scarp have been settled and cultivated by groups of Ibo people for a long period, and population has increased to give a density of well over 300 per sq. mile. The unit of Ibo settlement is the compound or a group of compounds, surrounded by compound land and outlying fields. Under a form of bush fallowing, or shifting of the outlying fields round the more permanent nucleus of compound land, the original vegetation, which was probably

dry forest, has long been cleared and burned. Today relics of oil-palm bush surround the compounds, but the rest of the area is deforested and covered by derived savanna, which often becomes sparse xerophytic grassland. The lowlands east of the scarp have never been so densely peopled, and it was only pressure of population on the upper plateaux that forced the Ibos to cultivate lower land, or to move down and settle permanently on the plains.

## EROSIONAL FEATURES OF THE SCARP (Fig. 2)

The scarplands combine a natural tendency to geological erosion with a history of clearing and cultivation continued long enough to transform the natural vegetation from dry forest to xerophytic grassland. Once the protective forest is removed, the friable nature of the underlying sandstones makes them easily susceptible to erosion. There is a well-marked dry season when the exposed, sandy soil dries rapidly, shallower rooting grasses and young seedlings die, and only deep-

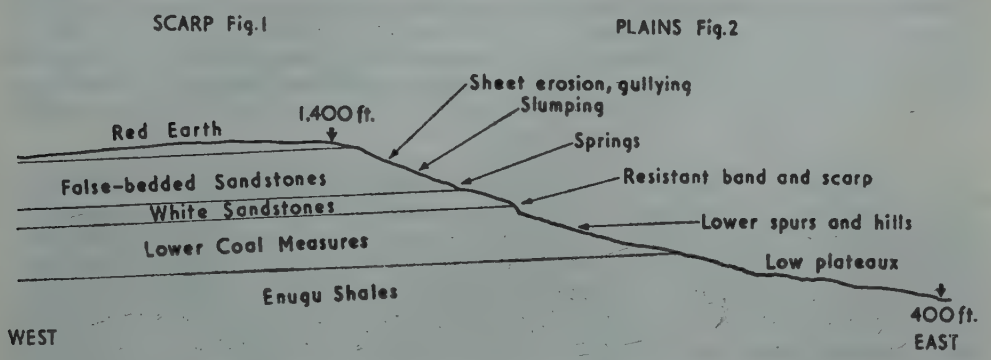


Fig. 1. Diagrammatic section across the Enugu escarpment.

rooted trees and grass seeds survive. At the beginning and end of the wet season violent storms occur, when the run-off over steep, bare slopes has great erosive power, causing sheetwash when dispersed and collapse in gully heads when concentrated. During the wet season from April to October, when rainfall is over 70 in., the surface layers become saturated, giving conditions favourable to mass movement of material on the valley sides, and causing the emergence of springs which erode locally by headward sapping.

The result of this combination of geological, climatic and human factors is the landscape shown in Fig. 2, forming part of what has been described as "Donga Ridge". Above point (1) is a complex system of "large, digitate gullies with vertical-walled, 'bulbous' heads."[1] The uppermost tributary gullies, shown in thick black lines, fall very steeply and are V-shaped in cross-section. They converge or descend along the sides of the main tributaries into steep-walled canyons, floored with white sand, which in their turn unite to form a much broader, major canyon cutting a deep trench into the scarp face.

### *(a) Upper Gully Zone*

The original upper surface survives entire in the west, and further east the ground slopes down the scarp face and down towards the main canyon, which obviously occupies a former line of drainage. The upper surface is distinguishable by the cover of Red Earth, but this seems to have been removed, probably by sheet

1. A. T. Grove, "Land use and soil conservation in parts of Onitsha and Owerri provinces," *Geological survey of Nigeria, Bulletin no. 21* (1951), p. 42.

erosion, from the lower ones, which are paler in colour and have much sparser vegetation. This is no doubt due to their position part-way down the scarp where slopes are steep. Whenever the edges of surfaces are shown on the map, they are clearly-marked break-points at the limit of headward erosion by the gullies.

The growth of the gullies by caving of their rims and slipping of their bounding walls eats back into the original surfaces. Headward erosion seems to have ceased, as among the upper lobes gully walls are stabilized by small bushes, but the amount of overall headward erosion into the scarp face in the past can be estimated as the distance between the westernmost gully heads and the eastern edge of the upper surface. Below the upper lobes many of the gully and canyon walls are bare and deeply furrowed, suggesting that side slipping is still active. This process leaves remnants of the original surface at all stages from great flat-topped spurs to reduced ridges with narrow necks and outlying mesas. Spurs and outliers in turn are attenuated to arêtes as walls of adjacent gullies converge. Sometimes, as at (4), breakdown occurs more rapidly at the upper end of the ridge, and the gully breaks through the neck, leaving a crumbling island arête. The final result is a chaotic pattern of gullies and disintegrating remnants. Vertical aerials do not bring out the colour contrasts which intensify this fantasy — sandstone beds are differentiated by all shades of white, yellow and pink, and Red Earth caps the surfaces or slips in a vivid red smear down the gully walls.

Breakdown of the surfaces has released large quantities of sandy sediment into the gullies and canyons. There is no permanent flow of water, but during the wet season the sediment is carried in the canyons and beyond the canyon zone into the plains course of the River Nyaba. The canyons therefore accumulate material in several forms. A sheet of alluvial white sand is deposited over the floor, sometimes as sandbanks bordering the main flood-water channel and mingling with material from the walls above. Debris from the walls blankets the change of slope from steep wall to canyon floor, and tributary gullies deposit cones which may coalesce to form steep-sided talus slopes. In at least two cases, where their edges are shown with firm lines on the map, the cones are flatter and sharply truncated by the main stream, appearing more like small fan-shaped terraces. Truncation is obviously the work of the main stream during the wet season; it may be purely seasonal after a heavy storm, or it may be a more permanent trend, indicating that the stream now receives less load of material from the upper gullies and has, therefore, greater erosive power.

*(b) Trench Course and Zone of Slumping*

Below point (1) there is a distinct change in both the form of the main canyon and its bounding walls. The canyon narrows at (1), (2) and (3) to a trenched course, with intervening steep-sided basins, and below (3) expands gradually into a normal valley. The same features can be seen in the form of its tributaries; E, F and L show stretches of gully and canyon succeeded by normal valleys, and below tributaries F and M all valleys are normal. Gully and canyon formation appears, therefore, to be confined to an upper zone, and ends at a definite lower line which is traceable from (1) along both the north and south banks of the main stream. This line represents the edge of the False-bedded Sandstones, and the outcrop of White Sandstones and below them the Lower Coal Measures. Because the two latter formations are compact and impermeable, they are more resistant to erosion. Tributary F demonstrates this as it broadens to a basin in this zone — downward cutting is retarded and replaced by more vigorous lateral cutting in the upper friable sandstones.

Where a thin cover of porous False-bedded Sandstones remains, water seeps through to the White Sandstones, creating a sort of lubricant layer where springs emerge at about 800 ft. on the hillsides. There is instability over the lubricant layer and the slopes are scarred with crescentic slumping. The slump has a fairly well-defined upper break, and the steeper slope below is seamed with small rills, which tend to develop into shallow gullies, especially where footpaths have concentrated the flow of water or to the west where the zone merges into the deeply gullied hillsides of the upper canyon. The slumps are old now, but movement by soil creep continues in the steeper slopes of the slump area, and terracettes can be distinguished at point (6).

Below the zone of slumping is a line of well-marked small scarps, which are a resistant bed in the lower White Sandstones and upper Coal Measures. This bed can be traced up tributary G and on either side of the main stream, being breached by the main stream near point (2). Wherever there are small tributaries the scarp is more pronounced, being undercut by the streams to form a hard lip over which the water plunges in a fall in the wet season. In some cases undercutting is sufficiently severe and the lip sufficiently resistant to form caves. The curved pattern of the crags, convex upstream, is evidence of headward sapping and movement of the fall upstream.

The original stream pattern in this intermediate zone would appear to have been a spring emerging in what is now the slump zone above the small scarp, descending by a gorge-like valley and over the scarp to join a larger tributary. The typical sequence as developed today is an upper course in a shallow amphitheatre caused by slumping, developing into a shallow gully, then plunging over the lip formed by arcuate crags to a normal stream course below. There is evidence on the map of many stages and variations in this process. At point (7) the scarp is intact and a stream, gullied only in its uppermost course, falls over the overhanging lip into a wooded, deeply recessed hollow in the valley side. At tributary M, which is further upstream and therefore runs over a greater area of False-bedded Sandstones, the gully courses, in what may be an old slump area, extend right down to the scarp, and the scarp itself has retreated to form a great embayment.

Canyons and stream courses are not by any means graded. Knickpoints remain at resistant rock bands as a sudden steepening and narrowing in the canyon floor. Sometimes a set of gullies converges into a flat-floored tributary canyon, and this may narrow and steepen to a gully course once or twice, alternating with canyon basins, before reaching the main canyon. At point (5) a tributary gully is hanging in relation to the main canyon and there are other examples of this. Tributary G has two knickpoints — an upper one, which is also present on all its lower tributaries, corresponds to the line of crags, but a lower one marks a change in valley cross-section to a slight incision of the valley floor. The same feature seems to be traceable in the main valley and may possibly represent the headward advance of a cycle of erosion. Tributary G is, in fact, complex, with one knickpoint at the line of crags, a lower one at the change in valley profile, and a series of terraces below this and at its outlet to the main stream, which are raised and sharply truncated.

Both zone (a) and zone (b), therefore, show evidence of advanced erosion, though details differ according to geology and position relative to the main scarp face. Among the upper lobes of the escarpment summit, flat-topped spurs end abruptly in near-vertical gully walls, but in zone (b) steep hillsides drop away to the main stream in scarred and broken walls of gentler gradient than the gully walls

of zone (a). Zone (b) is an area of inherent instability with the steep slopes of the scarp face which have a natural tendency to sheet erosion, slumping over the more compact sandstone and headward sapping where streams emerge. The upper part of zone (a) has degraded, but not naturally unstable, surface layers, due to lack of gradient, and the present intense gullying is a result of headward movement from zone (b). It is, therefore, difficult to point to any specific origins of the gully heads in the upper part of zone (a), but in zone (b) any slight disturbance in the form of cultivation or footpaths would rapidly lead to earth movement. Between tributaries D and E and tributaries F and G there are particularly clear examples of footpaths developed into gullies and being abandoned in favour of new paths, which later also develop gullies and are abandoned in their turn, leaving a series of parallel gullies and paths. Where this is succeeded by slumping on the slopes below, the combination results in a remarkable breakdown of the original hillside.

## DEPOSITIONAL FEATURES OF THE LOWER VALLEY (Fig. 3)

Fig. 3 shows the course of the River Nyaba after the junction of its main headwaters as it emerges from the scarp to the Enugu plains. The gradient of the valley floor decreases long before its exit from the scarp, but it is only beyond the scarp that the valley widens, the constricting walls decrease in height, and the speed of the river slackens so that it swings in a series of broad curves between low plateaux.

The bedrock changes from Lower Coal Measures to Enugu Shales, which are much less resistant and form the lowest land. Beds of the Lower Coal Measures are responsible for the higher plateaux and scarps to the west, and for the two hills with radiating spurs south of the river. River systems are normal, and adjustment to structure appears to control the trellis pattern of valleys and interfluves. The main trend, from north-east to south-west, follows the strike of the beds, and is seen in the long reaches of the main river and the tributaries N and O. Transverse to this, following the dip from north-west to south-east, are the shorter reaches of the main river and the smaller tributaries. The pattern is repeated in quite small detail, for example, the lake (9) with its longer axis from south-west to north-east and shorter extensions from north-west to south-east, and the low, wooded scarps of the ridges.

Material eroded from the gullies is carried downstream in the wet season and deposited in these bottomlands in a complex pattern of sedimentation. The photos were taken at the end of the dry season, and there is little evidence of surface water — a few tributaries enter the main channel and peter out in sand, and the rest of the flood-channel is recognizable only as a darker band of sediment. This channel, often braided, swings from side to side of a wide zone of sandbanks and terraces, the edges of which, indefinable and frequently changing, are shown by pecked lines on the map.

Sediment has piled up at the edges of the channel to form ridges which divert tributaries to find an entrance to the main river further downstream, and are high enough to dam them back in lagoons. There may even be a drainage system developed into the lagoons and away from the ridges of the main channel, as for example at (10).

The sweep of flood-water in the wet season round the meander curves accounts for the interplay of erosion and deposition in this unconsolidated sediment. Some areas, marked (11) on the map, show sharp truncation of terraces and sandbanks, and the outer bank of each bend is usually much clearer of silt, or may actually be

undercut as in areas marked (12). In other areas, marked (13), there is a wash of silt over old cultivation on terraces, and wide stretches are inundated with a sterile, white sand cover from the main flood channel. At point (14) sand has washed over a ridge in a finger-like pattern on to the lower land beyond. Just as there is this interplay of erosion and sedimentation in the channel, so there is an uncertain borderland between solid earth and sediment, where river alluvium from the tributaries, coarse sand from the main stream, and older river-terraces are intermixed.

Remnants of rain-forest are preserved up the tributary valleys, on the flanks of the two hills and along the small scarps bordering the longer tributaries. Much of the area shows signs of cultivation of various ages, though there is little present cultivation except round a group of compounds in the south-east, very loosely clustered among preserved woodland. Alluvial lands bordering the stream at the entrance of small tributaries, which must have some of the most fertile soils, show signs of cultivation, but again much is abandoned, and silt-wash over yam mounds and ridges (probably for cassava and ground-nuts) destroys this agricultural land. Cultivation along the banks of the main channel would appear to be a valued but uncertain part of the farming system.

A network of footpaths serves this lowland. Many can be traced across the river terraces and sandlands as far as the flood-channel, often converging on what must be a suitable fording-place. The main road from Enugu to Awgu crosses by a bridge in the extreme east of the map, where the channel narrows between firmer banks, and the course appears to be stable and more permanent. This road parallels the north-south road in the extreme west, running along the top of the scarp, roughly along the watershed.

## STAGE OF EROSION

The course of the River Nyaba on Figs. 2 and 3 shows clearly an area where heavy cultivation of the friable sandstones of the scarp has led to severe sheet and gully erosion on the steeper slopes, and the deposition of a great flood of sediment both in the canyon and, more seriously, over the cultivated lands bordering the plains course of the river. Erosion here became so serious and affected such a wide area that in 1922 the scarp was designated Udi Forest Reserves; cultivation was forbidden (though not always successfully) and soil conservation was put in hand.

The success of this can in some measure be seen from the aerial photos. The upper surfaces have only a sparse grassland cover but are no longer cultivated, and small gullies at point (8) have been checked by planting bushes. In the higher gullies and upwards from the talus slopes of the canyons planted shrubs are well established and colonizing the valley sides, though large areas are still bare and the major gully system will obviously take a long time to heal. Truncation of terraces and sandbanks by the main stream may also be evidence of decreasing destruction in the gullies and greater erosive power of the stream, consequent on its decrease of load.

On the other hand, the presence of knickpoints shows that conditions are not stable, and without firmly established vegetative cover, renewed erosion might easily be initiated. Hill-sides in the unstable (b) zone are not yet protected; the bottom-lands are still being destroyed by wash of sediment and this no doubt continues for some time after active erosion in the upper course ceases.

Conservation measures have, therefore, checked erosion so that gullying has now passed from Stage 2 of "Headward cutting and rapid enlargement" to Stage 3 of "Healing,"[1] though the latter is only begun, and removal of control could mean reversion to Stage 2. Erosion has been so vigorous and so far advanced that, even after 30 years of conservation, the picture preserved by the aerial photos portrays vividly, down to the smallest details, a landscape of advanced erosion and sedimentation.

1. H. A. Ireland, C. F. S. Sharpe and D. H. Eargle, *Principles of gully erosion in the Piedmont of S. Carolina, U.S. Department of Agriculture Technical Bulletin No. 633* (1939).

Fig. 2. The scarp course of the River Nyaba.

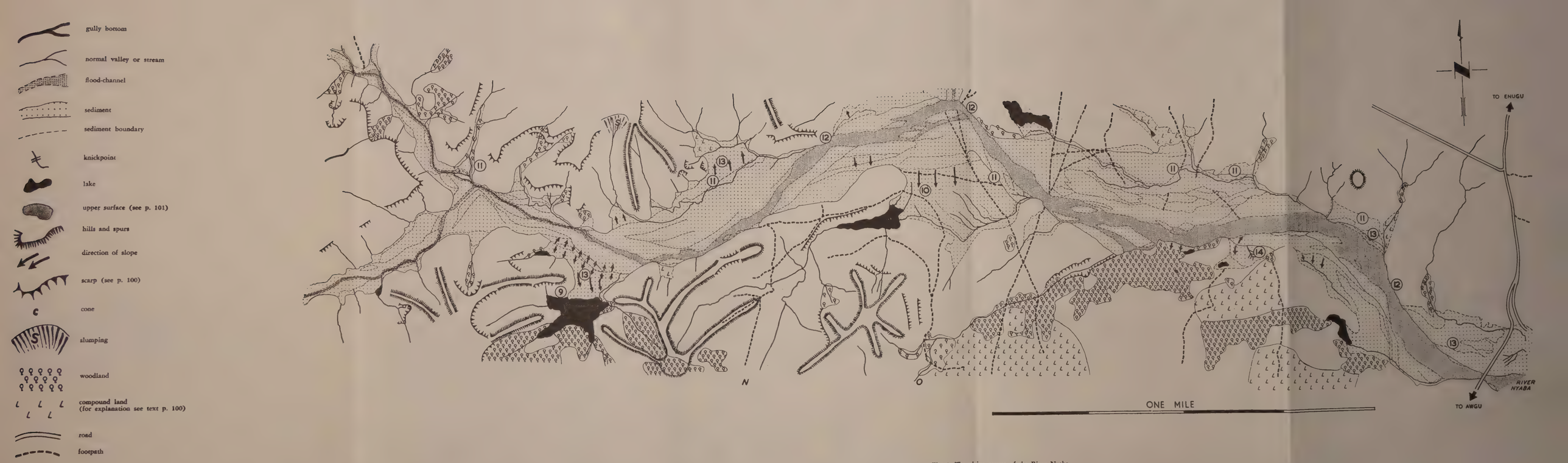


Fig. 3. The plains course of the River Nyaba.

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